European Investment Bank Induced GHG Footprint
The carbon footprint of projects financed by the Bank

Methodologies for the Assessment of Project GHG Emissions and Emission Variations

Version 10.1

The Pilot Carbon Footprint Exercise and GHG methodologies were conceived by the Environment, Climate and Social Office (ECSO) in the Projects Directorate of the EIB, with the assistance of an external consultant (En-Vision Limited). The Task Manager was Andrea Pinna, assisted by Giulia Macagno.

Completion of the Pilot, revision of the methodologies and the mainstreaming of calculations into projects appraisals has now been finalised. The task manager was Nancy Saich, assisted by Oliver Johnson and members of the Carbon Footprint Task Force.
CAVEAT

The methodologies contained in this document are designed primarily to guide EIB Project Directorate staff in the calculation of the carbon footprint of the projects financed by the Bank.

A number of caveats should be stressed from the outset.

First, carbon emissions result from virtually all human and natural activities. For example, even when the best available technologies are used when making cement, paper or steel, inevitably a significant quantity of CO₂ is emitted. The carbon footprint measures GHG emissions. However, evaluating the merit of a project requires comparing economic costs with benefits, including the costs and benefits in terms of incremental GHG emissions. Where appropriate, the Bank uses an economic (shadow price) of carbon to convert changes in tonnes of GHG into euros. In short, whilst the carbon footprint is an important metric in its own right, it should be seen within the context of the overall economic appraisal of a project.

Second, the recommended methodologies are by assumption restricted in scope. The carbon footprint does not purport to be a comprehensive life-cycle analysis of a project. Such an exercise can only be done credibly ex-post and with a large amount of information. The carbon footprint takes place ex-ante and with limited information and resources. For instance, downstream emissions from the use of the products and services resulting from EIB-financed projects are generally not considered. Examples are R&D projects in the area of efficient engines, a project to build a PV panel or wind turbine factory, and a bio-ethanol refinery project.

In summary, in considering the scope and nature of the EIB pilot carbon footprint exercise, readers should be mindful that the carbon footprint of a project per se cannot and should not be construed as an expression of the merit or value of that project, either broadly or more narrowly in climate change terms alone.

Additionally, for the sake of clarity it is important to bear in mind that the EIB footprint exercise (as defined) is separate and distinct from another exercise also recently undertaken to formulate and estimate a climate change Key Performance Indicator (KPI) as part of the Corporate Operational Plan (COP) of the Bank. The fact that a project is, or is not, included in the footprint assessment does not, at least in general terms, have any bearing on the classification of that same project as a climate change project for COP KPI purposes.

Finally, footprint work is relatively new. In the EIB it is considered “work in progress” that is subject to periodic review and revision in the light of experience gained and as knowledge of climate change issues evolves. ECSO welcomes comments and suggestions for improvement on the latest draft of the present document.

Peter Carter
Chief Environmentalist
3 August 2012
## REVISION HISTORY

<table>
<thead>
<tr>
<th>Revision No.</th>
<th>Issue Date</th>
<th>Amendment Description</th>
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<tbody>
<tr>
<td>Version 1</td>
<td>10 July 2009</td>
<td>First version issued following consultations on two draft editions.</td>
</tr>
<tr>
<td>v2</td>
<td>10 Sept 2009</td>
<td>Revisions to incorporated changes following internal review</td>
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<tr>
<td>v3</td>
<td>24 Sept 2009</td>
<td>Revisions to incorporated changes following launch of methodologies</td>
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<tr>
<td>v4</td>
<td>22 Oct 2009</td>
<td>Revisions following implementation of methodologies</td>
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<tr>
<td>v5</td>
<td>10 Nov 2009</td>
<td>Revisions to included amended baseline methodologies</td>
</tr>
<tr>
<td>v6</td>
<td>23 Nov 2009</td>
<td>Revisions following internal review</td>
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<tr>
<td>v7</td>
<td>24 Feb 2010</td>
<td>Revisions following internal review</td>
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<tr>
<td>v8</td>
<td>15 July 2010</td>
<td>Revision following internal review and comments</td>
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<td>v9.1</td>
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<td>Revision following internal review and comments</td>
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<td>V9.2</td>
<td>Q1 2012</td>
<td>Holding version after preliminary review by the Carbon Footprint Task Force. Issued before CSO Workshop</td>
</tr>
<tr>
<td>V10</td>
<td>Q3 2012</td>
<td>Revision following feedback from PJ CFTF¹, CSOs, MDB Working Group and the completion of the 3 year Pilot.</td>
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<tr>
<td>V10.1</td>
<td>Q1 2014</td>
<td>Table A2.3 updated with 2014 figures</td>
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</tbody>
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¹ The Carbon Footprint Task Force – adhoc group made up of a minimum of one PJ expert from each department tasked with reviewing sector methodologies.
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1. Objective

Most of the projects financed by the EIB emit greenhouse gases (GHG) into the atmosphere either directly (e.g. fuel combustion or production process emissions) or indirectly through purchased electricity and/or heat. In addition, many projects result in emission reductions or increases when compared to what would have happened in the absence of the project, referred to as baseline emissions.

The Bank has carried out a 3-year pilot phase from 2009-2011 to measure the impact in GHG emissions from the projects it finances\(^2\). This document sets out the methodologies to be applied going forward after the completion of the pilot. The methodologies allow for the estimation of two measures of GHGs from projects financed by the Bank:

- the absolute GHG emissions of the project, and;
- the variation in emissions compared to a baseline, referred to as the relative emissions, which can be either positive or negative.

The methodologies set out below are based upon the internationally recognised IPCC Guidelines and the WRI GHG Protocol. In the absence of project specific factors, the methodologies adopt an IPCC factor applicable at the global or trans-national level (termed tier level 1 in IPCC). The development of the methodologies has also been informed by ISO14064 parts 1 and 2 and the Voluntary Carbon Standard which provide guidelines for the development of greenhouse gas inventories at the corporate and project levels.

2. Guiding principles

Certain principles underpin the reporting of project-based GHG absolute, baseline and relative emissions. These principles should guide users in cases where the proposed EIB methodologies afford flexibility or discretion, or where a particular situation requires the application of a case specific factor. The application of these principles will help ensure the credibility and consistency of efforts to quantify and report emissions. These principles are:

Completeness
All relevant information should be included in the quantification of a project’s GHG emissions and in the aggregation to the total EIB-induced GHG footprint. This is to ensure that there are no material omissions from the data and information that would substantively influence the assessments and decisions of the users of the emissions data and information.

Consistency
The credible quantification of GHG emissions requires that methods and procedures are always applied to a project and its components in the same manner, that the same criteria and assumptions are used to evaluate significance and relevance, and that any data collected and reported allow meaningful comparisons over time.

Transparency
Clear and sufficient information should be provided to allow for assessment of the credibility and reliability of reported GHG emissions. Specific exclusions or inclusions should be clearly identified and assumptions should be explained. Appropriate references should be provided for both data and assumptions. Information relating to the project boundary, the explanation of baseline choice, and the estimation of baseline emissions should be sufficient to replicate results and understand the conclusions drawn.

\(^2\) The EIB Carbon Footprint Exercise includes direct Investment Loans and large Framework Loan allocations that meet the significant emissions thresholds defined in section 3. Other intermediated lending is not currently included due to the limited information available to carry out a useful calculation for numerous sub-projects.
Conservativeness
EIB should use conservative assumptions, values, and procedures. Conservative values and assumptions are those that are more likely to overestimate absolute emissions and underestimate negative relative emissions.

Balance
Balance means that the data set should reflect both the positive and negative aspects of the EIB GHG emissions performance to enable users to make a reasoned assessment of overall performance.

Accuracy
Uncertainties with respect to GHG measurements, estimates, or calculations should be reduced as far as is practical, and measurement and estimation methods should avoid bias. Where accuracy is sacrificed, data and estimates used to quantify GHG reductions (relative emissions) should be conservative.

3. Significant emissions
Not all projects need to be included in the GHG footprint and only projects with significant emissions are to be assessed. Based on the results of the first six months of the GHG footprint pilot in 2009 it was decided to set minimum project thresholds for inclusion in the GHG footprint exercise as follows:

- Absolute emissions greater than 100,000 tCO2-e
- Relative emissions (either positive or negative) greater than 20,000 tCO2-e

The results revealed that these thresholds capture approximately 95% of the absolute and relative GHG emissions from projects and are in line with those set by other financial institutions for their GHG accounting. Hence projects below these thresholds will not be included in the footprint exercise since they are not considered significant. Table 1 below illustrates the project types that may be included in the calculation of the GHG footprint. This list and categorisation is for guidance only.

The PJ expert is required to calculate and report 100% of a project’s emissions even if the Bank is only contributing a portion of the total project investment cost. At the reporting stage results will be prorated to EIB’s share of the financing plan.

<table>
<thead>
<tr>
<th>In general GHG assessment WILL NOT be required.</th>
<th>In general GHG assessment WILL be required.</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Telecommunications services.</td>
<td>* Municipal solid waste landfills;</td>
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<tr>
<td>* Civil construction projects.</td>
<td>* Municipal waste incineration plants</td>
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<tr>
<td>* Drinking water supply networks.</td>
<td>* Large waste water treatment with anaerobic landfill of sludge</td>
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<tr>
<td>* Small scale industrial waste water treatment and municipal waste water treatment</td>
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<tr>
<td>* Agricultural processing / Food manufacturing facilities</td>
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<tr>
<td>* Property developments.</td>
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<tr>
<td>* Mechanical/biological waste treatment plants</td>
<td></td>
</tr>
<tr>
<td>* R&amp;D activities</td>
<td></td>
</tr>
<tr>
<td>* Pharmaceuticals and biotechnology</td>
<td></td>
</tr>
<tr>
<td>Industry/Infrastructure</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td></td>
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<tr>
<td>Manufacturing Industry</td>
<td></td>
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<tr>
<td>Chemicals and refining</td>
<td></td>
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<tr>
<td>Mining and basic metals</td>
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<tr>
<td>Pulp and paper</td>
<td></td>
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<tr>
<td>Rolling stock, ship, transport fleet purchases</td>
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<tr>
<td>Road and Rail infrastructure</td>
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<tr>
<td>Power transmission lines</td>
<td></td>
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<tr>
<td>Renewable sources of energy</td>
<td></td>
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<tr>
<td>Fuel production, processing, storage and transportation</td>
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<tr>
<td>Cement and lime production</td>
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<tr>
<td>Glass production</td>
<td></td>
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<tr>
<td>Heat and power generating plants</td>
<td></td>
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<tr>
<td>District heating networks</td>
<td></td>
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<tr>
<td>Natural gas liquefaction and re-gasification facilities;</td>
<td></td>
</tr>
<tr>
<td>Gas transmission infrastructure;</td>
<td></td>
</tr>
</tbody>
</table>
Annex 2 also provides some detail as to project categories along with the main sources, types and expected scale of GHG emissions.

Greenhouse gases to be included within the footprint include the seven gases listed in the Kyoto Protocol, namely: carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF₆); and nitrogen trifluoride (NF₃). The GHG emissions quantification process converts all GHG emissions into tonnes of carbon dioxide called CO₂-e (equivalent). The following processes/activities usually generate GHGs that may be accounted for using the methodologies:

- **CO₂** – stationary combustion of fossil fuels, indirect use of electricity, oil/gas production & processing, flue gas desulphurisation (limestone based), aluminium production, iron and steel production, nitric acid production, ammonia production, adipic acid production, cement production, lime production, glass manufacture, municipal solid waste incineration, transport (mobile combustion);
- **CH₄** – biomass combustion or decomposition, oil/gas production & processing, coal mining, municipal solid waste landfill, municipal waste water treatment;
- **N₂O** – stationary combustion of fossil fuels/biomass, nitric acid production, adipic acid production, municipal solid waste incineration, municipal waste water treatment, transport (mobile combustion);
- **HFCs** – refrigeration / air conditioning / insulation industry
- **PFCs** – aluminium production
- **SF₆** – electricity transmission systems, specific electronics industries (e.g. LCD display manufacture).
- **NF₃** – plasma and thermal cleaning of CVD reactors

### Table 2: Selected examples of sources of direct GHG emissions by activity type.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>GHG Type</th>
<th>POTENTIAL SOURCES OF EMISSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMBUSTION FOR ENERGY</td>
<td>CO₂, N₂O</td>
<td>Energy related GHG emissions from combustion: boilers / burners / turbines / heaters / furnaces / incinerators / kilns / ovens / dryers / engines / flares / any other equipment or machinery that uses fuel, including vehicles.</td>
</tr>
<tr>
<td>COMBUSTION GAS SCRUBBERS</td>
<td>CO₂</td>
<td>Process CO₂ from flue gas de-sulphurisation (limestone based) units</td>
</tr>
<tr>
<td>IRON &amp; STEEL PRODUCTION</td>
<td>CO₂, N₂O</td>
<td>Coke Ovens: raw materials (coal or petrol coke) / conventional fuels (e.g. natural gas) / process gases (e.g. blast furnace gas (BFG)) / other fuels / waste gas scrubbing. Metal ore roasting, sintering or pelletisation: raw materials (calcination of limestone, dolomite and carbonatic iron ores, e.g. FeCO₃) / conventional fuels (natural gas and coke/coke breeze) / process gases (e.g. coke oven gas (COG) and blast furnace gas (BFG)) / process residues used as input material including filtered dust from the sintering plant, the converter and the blast furnace / other fuels / waste gas scrubbing. Production of pig iron and steel including continuous casting: raw materials (calcination of limestone, dolomite and carbonatic iron ores, e.g. FeCO₃) / conventional fuels (natural gas, coal and coke) / reducing agents (coke, coal, plastics, etc.) / process gases (coke oven gas (COG), blast furnace gas (BFG) and basic oxygen furnace gas (BOFG)) / consumption of graphite electrodes / other fuels / waste gas scrubbing.</td>
</tr>
<tr>
<td>CEMENT &amp; LIME MANUFACTURE</td>
<td>CO₂</td>
<td>Calcination of limestone in the raw materials / conventional fossil kiln fuels / alternative fossil-based kiln fuels and raw materials / biomass kiln fuels (biomass wastes) / non-kiln fuels / organic carbon content of limestone and shales / other materials used for waste gas scrubbing.</td>
</tr>
<tr>
<td>GLASS PRODUCTION</td>
<td>CO₂</td>
<td>Glass production: decomposition of alkali- and earth alkali carbonates during melting of the raw material / conventional fossil fuels / alternative fossil-based fuels and raw materials / biomass fuels (biomass wastes) / other fuels / carbon containing additives including coke and coal dust / waste gas scrubbing.</td>
</tr>
<tr>
<td>PAPER &amp; PULP MANUFACTURE</td>
<td>CO₂</td>
<td>Pulp and paper manufacture: power boilers, gas turbines, and other combustion devices producing steam or power for the mill / recovery boilers and other devices</td>
</tr>
</tbody>
</table>
### Activity | GHG Type | Potential Sources of Emission
---|---|---
**Aluminium Production** | CO<sub>2</sub>, PFCs, SF<sub>6</sub> | CO<sub>2</sub> from combustion sources. Process related GHG emissions: CO<sub>2</sub> from anode consumption (pre-baked or Soderberg) / CO<sub>2</sub> from anode and cathode baking / PFCs from anode effects (or events). Other process-related emissions that may occur, depending on the facility configuration, include: CO<sub>2</sub> from coke calcinations / SF<sub>6</sub> from use as a cover gas / SF<sub>6</sub> from use in on-site electrical equipment.

**Nitrile Acid Production** | CO<sub>2</sub>, N<sub>2</sub>O | CO<sub>2</sub> from combustion sources and process related.

**Ammonia Production** | CO<sub>2</sub> | CO<sub>2</sub> from combustion sources and process related.

**Adipic Acid Production** | N<sub>2</sub>O | CO<sub>2</sub> from combustion sources and process related.

**Biological Waste Treatment Plants** | CH<sub>4</sub> | CH<sub>4</sub> from anaerobic digestion of biodegradable waste

**Municipal Solid Waste Incineration** | CO<sub>2</sub>, N<sub>2</sub>O | GHGs from MSW combustion.

**Municipal Solid Waste Landfills** | CH<sub>4</sub> | CH<sub>4</sub> from anaerobic digestion of biodegradable waste

**Refrigeration / Air Conditioning / Insulation Industry** | HFCs | Fugitive losses of HFCs

**Power Transmission** | SF<sub>6</sub> | Transmissions losses will be derived from the power production combustion sources and have an associated emission of CO<sub>2</sub> / Fugitive losses of SF<sub>6</sub>

**Specific Electronics Industry (Semiconductors, LCD)** | PFCs, NF<sub>3</sub> | Fugitive losses of PFCs and NF<sub>3</sub>

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4. **Project boundaries (see figure 1a/b)**

The project boundary defines what is to be included in the calculation of the absolute, baseline and relative emissions. The EIB methodologies use the concept of “scope” as defined by the WRI GHG Protocol ‘Corporate Accounting and Reporting Standard’, when defining the boundary to be included in the emissions calculation.

**Scope 1: Direct GHG emissions.** Direct GHG emissions physically occur from sources that are operated by the project within the project boundary. For example emissions produced by the combustion of fossil fuels, by industrial processes and by fugitive emissions inside the project boundary.

**Scope 2: Indirect GHG emissions.** Scope 2 accounts for GHG emissions from the generation of electricity that is consumed by the project. The indirect emissions are produced outside the project boundary (i.e. at power plant level) but since a project has control over consumption and can improve it with energy efficiency measures, emissions should be allocated to the project. As a guide, in Europe purchased electricity of over 232 GWh/yr will result in scope 2 emissions for a project of over 100 ktCO<sub>2</sub>/yr.

**Scope 3: Other indirect GHG emissions.** Scope 3 emissions are a consequence of the activities of the project but that occur from sources not operated by the project.

**Only scope 1 and Scope 2 GHG emissions of projects are normally included in the footprint exercise.**
From the results of the 2009 six month pilot exercise and through meetings with other IFIs to harmonize approaches to carbon footprinting it was decided that scope 1 and 2 emissions will be included in the carbon footprint exercise. For the majority of projects financed by the Bank these are the most significant emissions associated with the projects. However, for certain physical infrastructure links such as road, rail and public transport, indirect emissions resulting from the use of the project, i.e. scope 3 emissions, are included since they are the most significant emissions associated with these project types and can be estimated on parts of the network. These are illustrated in figure 1b and table 3. Inclusion of scope 3 indirect emissions in some other types of network projects is under review by the EIB as part of the ongoing work on methodologies.
Table 3: Carbon Footprinting of projects: boundary clarifications

<table>
<thead>
<tr>
<th>PROJECT TYPE</th>
<th>FOOTPRINT BOUNDARY CLARIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL PROJECTS (except certain network projects)</td>
<td>A typical year of operation is used as the assessment period. Scope 1 and 2 emissions for the operation are included. Scope 1 and 2 emissions associated with the commissioning / construction and decommissioning phases of projects are excluded. EXCLUSION: all Scope 3 GHG emissions.</td>
</tr>
<tr>
<td>NETWORK PROJECTS</td>
<td>INCLUSION: (Transport networks) GHG emissions from vehicles travelling on the financed physical infrastructure links are included. The GHG relative emissions are calculated based on the displacement of passengers from one type of transport to another (modal shift effects), shifts in travel patterns (one road to another or from one time of day to another) and the induced increase in passengers / traffic. If the Project also includes the replacement of rolling stock, the savings in emissions from this intervention should also be taken into account. This can be both direct - e.g. scope 1 when replacing buses, or indirect – e.g. scope 2 when replacing trams.</td>
</tr>
<tr>
<td></td>
<td>INCLUSION: (power or fuel networks) GHG emissions from Scope 3 emissions may be included where they are significant – UNDER REVIEW</td>
</tr>
<tr>
<td>INDUSTRIAL PRODUCTION FACILITIES</td>
<td>EXCLUSION: GHG baseline emissions from replaced imported industrial output and associated transport emissions from these imports. Alternative regional production may be considered.</td>
</tr>
<tr>
<td></td>
<td>EXCLUSION: The impact downstream of the industrial product is not considered. For example, use of steel to make wind turbines; or glass to double glaze windows would not be considered (see point below on 100% dedicated upstream and downstream sources).</td>
</tr>
<tr>
<td>ALL PROJECTS</td>
<td>INCLUSION: Significant GHG emissions from 100% dedicated sources upstream or downstream that would not otherwise exist. For example, a coal mine that exists solely to supply the project (upstream) or a waste disposal site that is for the exclusive use of the project (downstream) that would not otherwise exist.</td>
</tr>
<tr>
<td>ALL REHABILITATION / REFURBISHMENT PROJECTS</td>
<td>CLARIFICATION: The boundary for projects to rehabilitate or refurbish existing facilities corresponds to the boundary of the rehabilitation or refurbishment project and not the GHG emissions for the whole facility.</td>
</tr>
<tr>
<td></td>
<td>Example 1: EIB invests in a project to rehabilitate a boiler house at a petrochemical refinery. EIB is contributing 40% of the overall investment for this project. EIB calculate 100% of the boiler house Scope 1 and 2 absolute and baseline GHG emissions. EIB does not report the whole refinery GHG emissions.</td>
</tr>
<tr>
<td></td>
<td>Example 2: EIB invests in a project to replace 5% of a pipeline network. The EIB is contributing 20% of the overall investment for this project. The EIB calculate 100% of the emissions associated with the project, i.e. losses for 5% of the network which will be prorated at annual aggregation. EIB does not report the whole network losses. UNDER REVIEW</td>
</tr>
</tbody>
</table>

Carbon leakage is not considered in the carbon footprint calculations (see point on industrial production facilities in Table 3). Leakage normally occurs as a result of climate policies of one country leading to a shift in emissions sources to another but may also occur as the result of a EIB financed project for example when an old technology is replaced and sold on to be used elsewhere.
Figure 1a: Project scope – all projects excluding road, rail and urban public transport infrastructure

Figure 1b: Project scope – road, rail and urban public transport infrastructure networks

Scope 1 emissions are not normally applicable in transport infrastructure projects as there are not usually direct emissions associated with the infrastructure.

Note: emissions from vertically-integrated transport systems, where the infrastructure owner operates the vehicles using the infrastructure are considered scope 2 emissions.

Note: power and fuel networks are under review.
5. Metrics

5.1 Emissions Factors
The EIB Carbon Footprint Methodologies provide a series of emissions factors from which greenhouse gas emissions can be calculated. These have been derived from internationally recognised sources, e.g. WRI/WBCSD GHG Protocol and IPCC Guidelines for National GHG Inventories. These default factors can be used where no other relevant factor is available or where factors that have been provided, by the promoter for example, appear to be unsubstantiated. Where possible it is preferable to use project specific factors in place of the defaults given here provided the source of the factors used is consistent with the guiding principles described in section 2 of the methodologies.

5.2 Absolute emissions (Ab):
A project’s absolute GHG emissions (gross emissions) will be quantified where those emissions are likely to reach the significant thresholds: >100,000 kt CO₂e/yr and >20,000 kt CO₂e/yr relative emissions (positive or negative) as defined in section 3 of the manual. Relevant emissions concern a project’s emissions from a typical year of operation i.e. not including commissioning or unplanned shutdowns. The appraisal team is expected to calculate and report the project’s absolute emissions even though EIB is only contributing a part of the total financing plan.

The absolute GHG emissions will be calculated based on project-specific data. Where project-specific data is not available it is good practice to use default factors based on sector specific activity data and through the application of documented emission factors. Emissions will be estimated by multiplying activity data, such as the volume of fuel used or product produced, by a project-specific or an industry default emission factor.

The EIB has adopted an approach based on the WRI GHG Protocol and IPPC Guidelines and consistent with the Bank’s economic analysis of projects. A compilation of default methodologies by sector is attached as Annex 2 to this note for guidance.

The methodologies are separated into combustion emissions and those emissions arising from a process other than combustion, normally the result of a chemical reaction during a production process or as a result of a processing stream. Emissions may also be fugitive where a leak or vent of a GHG occurs from some part of the project installation such as a valve or circuit breaker.

A combination of methodologies can be used where appropriate. For example a project which has:

- onsite energy generation through fuel combustion e.g. generators, boilers or kilns and;
- uses purchased electricity from the national grid and;
- has an associated process type emission e.g. cement production

can use a combination of Annex 2 methodologies to calculate absolute emissions for the project as follows:

\[ 1A \text{ Stationary fossil fuel combustion} + 1E \text{ Purchased electricity} + 6 \text{ Cement (clinker) production} \]

5.3 Baseline emissions (Be):
Measuring baseline emissions is a useful complement to absolute emissions. It provides a credible alternative scenario without the project, with which the ‘with’ project scenario can be compared – giving an indication of how, measured in GHG metrics, the proposed project performs. However, this ‘without’ project scenario, or baseline, is clearly theoretical and hence incorporates an additional level of uncertainty beyond those involved in estimating absolute emissions.
The project baseline scenario (or “without project” scenario) is defined as the expected alternative means to meet the output supplied by the proposed project\(^3\).

The baseline scenario must therefore propose the likely alternative to the proposed project which (i) in technical terms can meet required output; and (ii) is credible in terms of economic and regulatory requirements. The choice of baseline should normally be approached in the same way as the expected alternative scenario is determined for the project economic analysis.

The first step is to propose a baseline scenario which meets demand in technical terms. Three examples – expanded in detail below – are:

- **Example 1:** a new conventional thermal power plant is introduced into an electricity network with zero demand growth; without the new plant, the existing power plants connected to the grid (‘the operating margin’) would have continued to meet demand. By contrast, if demand is growing sharply, supply would have been provided in part existing capacity and in part by alternative new generation capacity (‘build margin’) or in part through a regional grid interconnection.
- **Example 2:** modernising a cement plant. Without the project, alternative regional plants would have met demand.
- **Example 3:** new link on a transport network. Without the link, the existing demand plus the underlying growth in demand would have been met across the existing network, albeit with inferior performance (higher congestion; lower service reliability etc), which would have also resulted in the end in an unexpressed demand/in a lower demand growth rate.

In a second step, it is necessary to check that the proposed scenario is credible. The baseline scenario should meet three conditions:

- **The socio-economic test:** in general terms, the baseline scenario should show an economic rate of return above the social economic discount rate. In the specific case that external costs are internalised through public policy (carbon tax; emissions trading scheme etc) the financial rate of return of the baseline scenario should not differ significantly from the ERR;
- **The legal requirement test:** the baseline alternative could not fail to comply with binding legal requirements (either technology, safety or performance standards, including portfolio standards e.g. 10% biofuels in fuel mix);
- **The life-expired asset test:** the baseline alternative could not assume to continue using existing assets beyond their economic life (based on regular operations and maintenance) at least not without appropriate deterioration in quality of service.

This baseline definition differs in general from an evaluation of emissions ‘before and after’ the investment.

- By definition, emissions prior to developing on a greenfield site are zero. Hence, applying a simple “before and after” approach gives rise to a zero baseline. By contrast, the baseline scenario defined above, i.e. without project scenario, places no weight on whether development is greenfield, brownfield or partial replacement – the key issue is how the projected demand could otherwise have been met, which is not addressed in the ‘before and after’ scenario.
- If the project is designed to replace a life-expired asset, a “before and after” approach would use previous emissions as the baseline. However, this approach may lack credibility in many cases if, for example, the existing asset is life expired and could not have continued over the course of the asset life of the proposed project.

\(^3\) In general the baseline scenario is based on a combination of best available technology and least cost principles. In some circumstances, one could also assess alternative scenarios in which prices or regulatory requirements are used to determine options or constrain demand to existing supply. This is relevant where current pricing is clearly inefficient.
5.4 Relative emissions (Re)
Relative emissions, also called net emissions, are defined simply as:

\[ \text{Relative Emissions} = \text{Absolute Emissions} - \text{Baseline Emissions} \]

\[ (Re = Ab - Be) \]

i.e. the difference between absolute and baseline emissions\(^4\). Relative emissions may be positive or negative: where negative, the project is expected to result in a savings in GHG emissions relative to the baseline and vice versa (subject to the general caveats surrounding the carbon footprint methodologies). Expressing a project’s relative carbon footprint is one way of evaluating the impact of a project in emissions terms since it provides a context to the absolute emissions of the project, i.e. whether the project reduces or increases GHG emissions overall. This can then be used as an indicator, along with others, of the environmental performance of the project.

A project is included in the footprint exercise if relative emissions (positive or negative) in absolute value\(^5\) are greater than 20 kt CO\(_2\)e/yr, even if absolute emissions are less than 100kt CO\(_2\)e/yr

The examples below present the approach the EIB typically takes for project carbon footprinting in three sectors: energy, industry and transport. All projects use an average year of operation during the economic lifespan of the project.

**Example 1: A New Combined-cycle natural gas-fired (CCGT) power plant in Austria**

**Absolute emissions**
The new CCGT plant is expected to generate approximately 5,000 GWh per annum. The resulting CO\(_2\) emissions are estimated to be 0.359kg/kWh, based on plant efficiency of 56% and the default emission factor for natural gas 56100 kg CO\(_2\)e/TJ. Therefore the absolute emissions are:

\[ Ab = (5,000 * 0.359) * 1,000 = (approx) 1,800,000 \text{ tons CO}_2\text{e per annum} \]

**Baseline emissions**
Austrian energy demand growth is less than 5% meaning that part of the energy generation from the project will replace less efficient firm\(^6\) generation in the grid (the operating margin) and part will meet the demand growth (build margin). In cases where demand growth is less than 5%, 50% of the baseline will be represented by generation from existing power plants (operating margin) and 50% from alternative new plants (build margin), where in mainland Europe the build margin is assumed to be gas-fired CCGT plant. The weighted average emission factor is derived from these two:

Operating Margin = 0.652kg CO\(_2\)/kWh
Build Margin = 0.354kg CO\(_2\)/kWh
Weighted average = 0.503kg CO\(_2\)/kWh

Therefore:
\[ Be = (5,000 * 0.503) * 1000 = 2,515,000 \text{ tons CO}_2\text{e per annum} \]

**Relative emissions**
\[ Re = 1,800,000 – 2,515,000 = \textbf{Minus 715,000 tons CO}_2\text{e per annum} \]

Overall the project, compared to the baseline scenario is expected to result in a reduction in emissions of 715,000 tons CO\(_2\) per annum due to the displacement of less efficient firm generation that is currently produced in the Austrian grid.

---

\(^4\) Electricity networks and pipeline projects may require an adjustment to boundaries of the with and without project scenario in order to calculate the relative emissions in a way that captures the significant emissions affected by the project downstream and upstream – UNDER REVIEW.

\(^5\) Meaning either an increase or a decrease larger than +20 kt CO2e/yr

\(^6\) Firm generation is the energy or the generation capacity which can be guaranteed to be available upon demand at a given time
Example 2: Modernisation of a Cement Plant in Italy

Absolute emissions
The cement plant substitutes in part clinker with slag from a nearby steel plant. The plant produces 1,200,000 tons of cement using 800,000 tons of clinker. The conversion factor for clinker production is 0.83 kg CO₂e/t clinker. The plant also purchases electricity at 40 Kwh/t cement produced converted to CO₂e using the Italian grid average of 405 kg CO₂/MWh.

\[ Ab = (800,000 \times 0.83) + (40 \times 1.2 \times 0.405 \times 1000) = 683,440 \text{ tons CO₂e per annum} \]

Baseline emissions
Cement markets are predominantly regional and so the baseline reflects how demand would be met locally. For the same amount of clinker, 800,000 tons, regional cement plants would be able to produce 900,000 tons of cement. The additional 300,000 tons to meet the same production level as the project scenario is calculated using the same clinker mix of 90% at regional level: 270,000 tons. The total clinker use in the baseline is therefore 1,070,000 tons. Purchased electricity is 50 Kwh/t cement produced.

\[ Be = (1,070,000 \times 0.83) + (50 \times 1.2 \times 0.405 \times 1000) = 905,300 \text{ tons CO₂e per annum} \]

Relative emissions
\[ Re = 683,440 - 905,300 = \text{Minus 222,300 tons CO₂e per annum} \]

Overall the project, compared to the baseline scenario is expected to result in a reduction in emissions of 222,300 tons CO₂e per annum. This is due to the part replacement of high emitting clinker with slag from a neighbouring steel plant.

Example 3: Rehabilitation of a Railway Line

For rail infrastructure projects, the forecast for carbon footprint is undertaken whenever a cost benefit analysis (CBA) is prepared. The CBA for such projects is normally performed using the Bank’s proprietary excel based model, RAILMOD

Absolute emissions
The project concerns the modernization of an existing twin track line for about 140 km. The line usage is about 60 electric powered trains per day. The absolute emissions are calculated from a multiplication of the assumed power consumption, in this case 10.5 kWhr per train km, the assumed grid emission factor of 655 g per kWhr, the total train km per year (current timetable) and the assumed growth in train km over time, including for demand induction as a result of the project (EIB Services assumption based on national plans).

The absolute forecast based on these inputs comes to 20,000 tons per average operating year.

Baseline emissions
RAILMOD assumes that demand comes from two sources (i) diverted from existing modes and, if appropriate (ii) induced. In this example, the vast majority of opening year passenger traffic is forecast to be diverted from existing rail. A portion is also diverted from buses (4%) and cars (4%) and a portion is induced (about 10% on average). The passenger demand diverted from other modes provokes a change in emissions; in this case, their movement by rail gives rise to a reduction of absolute emissions or correspondingly an increase in baseline emissions (i.e. in the baseline, a portion of traffic is assumed to travelling by car/bus, at a higher emission rate per passenger km). The induced traffic, to the extent that it requires additional rail services, increases the absolute emissions (or correspondingly, reduces the baseline emission).

The baseline forecast comes to 25,000 tonnes per average operating year.
Relative emissions

\[ Re = 20,000 - 25,000 = \textbf{Minus 5,000 tons CO}_2\text{e per annum} \]

6. Quantification process and methodologies

Figure 3 illustrates the overall series of activities to quantify the EIB carbon footprint for investment projects and the associated relative emissions compared to the baseline.

Figure 3 Project carbon footprint calculation flow

\[ \text{DEFINE PROJECT BOUNDARY} \]

\[ \text{EMISSION SCOPES TO INCLUDE} \]

\[ \text{(SEE FIGURE 1a/b)} \]

\[ \text{QUANTIFY ABSOLUTE (Ab) PROJECT EMISSIONS} \]

\[ \text{See ANNEX 2} \]

\[ \text{IDENTIFY & QUANTIFY BASELINE (Be) EMISSIONS} \]

\[ \text{CALCULATE RELATIVE (Ne) EMISSIONS} \]

\[ Re = Ab - Be \]

\[ \text{NB If a project’s absolute emissions or its relative emissions variation from the baseline scenario reach the thresholds shown, it is included in the EIB Carbon Footprint Exercise. If it is below this threshold, it is not included:} \]

\[ \geq 100,000 \text{ tonnes CO}_2\text{e ABSOLUTE threshold for inclusion} \]

\[ \geq 20,000 \text{ tonnes CO}_2\text{e RELATIVE threshold for inclusion (in absolute value)} \]
6.1 The assessment of intermediated projects
The quantification of the carbon footprint for multi-investment intermediated projects (e.g. Framework Loans, Global Loans, Funds,) poses challenges. Information of large numbers of sub-projects is highly limited, which does not permit a reasonable assessment of sub-projects, especially smaller ones and those targeting SMEs. Intermediated lending through these types of vehicles is not currently included in the carbon footprint exercise, except for large allocations of Framework Loans which are subject to individual appraisals. These should be treated as Investment Loans and included in the footprint exercise if emissions are above the thresholds, in the year the allocation is approved by the Bank.
ANNEX 1: EMISSIONS CALCULATIONS BY PROJECT

GUIDANCE:

The following tables provide a breakdown of typical EIB project types. The centre column of each table gives direction to the separate Annex 2 table where the calculation methodology is described. The table also gives an indicative guide as to the likely sizes of emission from the respective project type and whether it is likely to exceed the absolute or relative emissions inclusion threshold.

All project categories with expected absolute emissions below 100 ktCO2e or relative emissions variations (in absolute value) below 20 ktCO2e are excluded from the footprint calculations.

These lists are only indicative and there is no “one-size-fits-all” approach to estimating GHG emissions. Some projects with theoretically negligible emissions may in fact be large emitters or efficient savers (new processes, adoption of energy efficiency measures, usage of renewable energy sources, etc.). In these cases PJ staff are requested to use their professional judgement and if possible, contact other expert teams to build up a case-by-case solution for GHG measurement.
### ENERGY/ENSEC:

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute kt CO₂e</th>
<th>Expected relative kt CO₂e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil fuel fired power plants</td>
<td>1A Stationary Combustion of Fossil Fuels</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Combined heat and power cogeneration plants (CHP)</td>
<td>1A Stationary Combustion of Fossil Fuels</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Waste to energy power/CHP plants</td>
<td>1G Stationary Combustion of waste fuels. 1F Renewable Energy Projects.</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>District heating networks</td>
<td>1A Stationary Combustion of Fossil Fuels</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Natural gas, oil and LNG pipelines, storage &amp; distribution networks</td>
<td>1A Stationary Combustion of Fossil Fuels 1E Purchased electricity 2 Oil/gas production, processing, storage and transport</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Electric transmission networks</td>
<td>4 Electricity transmission &amp; distribution 1E Losses of electricity from the transmission and distribution network - use 1E Purchased electricity</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Electric distribution networks</td>
<td>4 Electricity, gas and heat transmission &amp; distribution 1E Purchased electricity (for network losses)</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Expansion of nuclear enrichment capacity of existing plants</td>
<td>1E Purchased electricity</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Gas, LNG and oil production and processing refineries</td>
<td>1A Stationary Combustion of Fossil Fuels 2 Oil/gas production, processing, storage and transport</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
</tbody>
</table>
## ENERGY/EE&RE:

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute emissions (kt \text{ CO}_2\text{e})</th>
<th>Expected relative emissions (kt \text{ CO}_2\text{e})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass combustion units</td>
<td>1F Zero absolute emissions for the biomass fraction of the fuel</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Hydropower plants run of the river</td>
<td>1F Zero absolute emissions</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Hydropower plants reservoir</td>
<td>12 Reservoirs emissions</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Pumping hydropower plants</td>
<td>12 Reservoirs emissions, 1E Purchased electricity</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Geothermal power plants</td>
<td>1E Purchased electricity, 2&amp;3 Fugitive CO2 and methane emissions</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Wind Farms</td>
<td>1F Minor absolute emissions, significant potential relative (negative) emissions</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Solar photovoltaic parks</td>
<td>1F Minor absolute emissions, significant potential relative (negative) emissions</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Solar thermal power generation</td>
<td>1A Stationary Combustion of Fossil Fuels, 1F Significant potential relative (negative) emissions</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Energy efficiency excl. cogen</td>
<td>1E Purchased electricity</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Carbon capture and Sequestration</td>
<td>1F Renewable Energy Projects. Minor absolute emissions associated with power for compression and pumping etc., 1E purchased electricity and possible fossil fuel combustion.</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
</tbody>
</table>

## MOBILITY/A&M:

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute emissions (kt \text{ CO}_2\text{e})</th>
<th>Expected relative emissions (kt \text{ CO}_2\text{e})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic control systems</td>
<td>None</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Airport capacity expansion</td>
<td>Scope 1 and 2 emissions do not normally meet the thresholds.</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Acquisition of aircraft and fleet upgrading</td>
<td>11 Other transport</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Port and airport rehabilitation works</td>
<td>None</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Ports capacity expansion</td>
<td>Scope 1 and 2 emissions do not normally meet the thresholds.</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>
## MOBILITY/ROADS:

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute emissions ( \text{kt CO}_2\text{e} )</th>
<th>Expected relative emissions ( \text{kt CO}_2\text{e} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>New road construction</td>
<td>8 Road Transport</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Roads rehabilitations</td>
<td>8 Road Transport</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>

## MOBILITY/PTR:

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute emissions ( \text{kt CO}_2\text{e} )</th>
<th>Expected relative emissions ( \text{kt CO}_2\text{e} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>New rail construction</td>
<td>8 Rail Transport</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Rail rehabilitation</td>
<td>8 Rail Transport</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Acquisition of locomotives or self propelled passenger trains</td>
<td>11 Other Transport</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Urban transport – Bus service</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Urban transport – Metro, light rail, tramway</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Urban public transport infrastructure (metro, light rail, tramway projects)</td>
<td>10 Urban Transport</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Urban transport – Acquisition of rolling stock</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>

## INCO/I2:

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute emissions ( \text{kt CO}_2\text{e} )</th>
<th>Expected relative emissions ( \text{kt CO}_2\text{e} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D investments</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>RDI focusing on development of innovative products and more efficient production processes</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>R&amp;D investment in equipment and tooling for industrial production, construction and mining.</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Semiconductor manufacturing - construction and operation wafer plants DEE</td>
<td>1E Purchased electricity</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Construction of industrial parks, shopping malls, congress centres etc.DEE</td>
<td>N/A Where dedicated CHP or power generation is part of project, this to be assessed using same</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>INCO/DEE:</td>
<td>Annex 2 methodologies and scope of emission</td>
<td>Expected absolute emissions kt CO₂e</td>
<td>Expected relative emissions kt CO₂e</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>--------------------------------------------</td>
<td>-------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Deployment of satellite communications</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Installation, upgrading and/or expansion of fixed telecommunications network</td>
<td>1E Purchased electricity for the full network (core, backhaul, access, Network Operation Center, etc...). 1E Purchased electricity of the CPE’s. For new network roll-out, baseline should refer to state of</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>
If the project includes swap-out of existing equipment, previous technological generation should be used for baseline to allow to capture the increase in energy efficiency.

### Installation, upgrading and/or expansion of mobile telecommunications network

<table>
<thead>
<tr>
<th>1E Purchased electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where significant numbers diesel generators are installed for the base stations then also use 1A Stationary combustion</td>
</tr>
<tr>
<td>Power consumption of mobile handsets is not to be included.</td>
</tr>
<tr>
<td>For new network roll-out, baseline should refer to state of the art equipment.</td>
</tr>
<tr>
<td>If the project includes swap-out of existing equipment, previous technological generation should be used for baseline to allow to capture the increase in energy efficiency.</td>
</tr>
</tbody>
</table>

### Semiconductor and LCD manufacturing - construction and operation wafer plants

<table>
<thead>
<tr>
<th>1E Purchased electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 PFC emissions from production process</td>
</tr>
</tbody>
</table>

### Installation, upgrading and/or expansion of submarine cables

| 1E Purchased electricity |

### R&D Investments

| N/A |

## INCO/LSH:

### Typical EIB project categories

<table>
<thead>
<tr>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute emissions kt CO\textsubscript{2}e</th>
<th>Expected relative emissions kt CO\textsubscript{2}e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment in healthcare, social services and education sectors</td>
<td>N/A</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Construction of hospitals</td>
<td>N/A</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Construction of Universities and schools</td>
<td>N/A</td>
<td>&lt;100</td>
</tr>
<tr>
<td>R&amp;D investments</td>
<td>N/A</td>
<td>&lt;100</td>
</tr>
<tr>
<td>RDI focusing on development of innovative products and more efficient production processes</td>
<td>N/A</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Manufacturing of chemical products and pharmaceuticals</td>
<td>1E Purchased electricity</td>
<td></td>
</tr>
<tr>
<td>Emissions from process and fuel consumption</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**ERD/NARA:**

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute or emissions $\text{kt CO}_2\text{e}$</th>
<th>Expected relative emissions $\text{kt CO}_2\text{e}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion of particle board and medium density fibreboard factory</td>
<td>N/A</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Food manufacturing facilities</td>
<td>1E Purchased electricity</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Pulp and paper plants construction or improvement</td>
<td>6 Pulp and paper production 1A Stationary Combustion of Fossil Fuels 1E Purchased electricity</td>
<td>&gt;100</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Biofuel production plants</td>
<td>1A Stationary Combustion of Fossil Fuels 1E Purchased electricity</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>

**ERD/REGU:**

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute or emissions $\text{kt CO}_2\text{e}$</th>
<th>Expected relative emissions $\text{kt CO}_2\text{e}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban renewal – social housing and public buildings.</td>
<td>Note: Most of these projects are financed through Framework Loans and do not qualify for inclusion in the footprint. However in the event of inclusion use 1E Purchased electricity. Guide: 3300 average UK households combined emit approx 20 ktCO$_2$e per year (Energy Savings Trust, 2009). An average UK house emits 3.5 tCO$_2$e/yr from gas heating and 2.5 tCO$_2$/yr from electricity use.</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Refurbishment of public existing infrastructure</td>
<td>1A Stationary Combustion of Fossil Fuels 1E Purchased electricity 4 Electricity, gas and heat transmission and distribution 17 Building Refurbishment</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Regional development</td>
<td>N/A: These projects are financed through Framework Loans and only large allocations are included in the footprint. Sector methodologies should be used.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**ERD/W&WM:**

<table>
<thead>
<tr>
<th>Typical EIB project categories</th>
<th>Annex 2 methodologies and scope of emission</th>
<th>Expected absolute or emissions $\text{kt CO}_2\text{e}$</th>
<th>Expected relative emissions $\text{kt CO}_2\text{e}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply, transmission and distribution facilities</td>
<td>1E Purchased electricity Energy demand of &gt;58 GWhr / yr (in Europe) will result in &gt;20 ktCO$_2$e</td>
<td>&lt;100</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Waste water and sludge treatment facilities</td>
<td>1E Purchased electricity 7 CH4 Waste Water &amp; Sewage Treatment Guide: with anaerobic landfill of sludge for facilities</td>
<td>&lt;100</td>
<td>&gt;20</td>
</tr>
</tbody>
</table>
serving >700,000 people equivalent, or with no landfill and serving more than 300,000 pop.e will generate >100 kt CO₂e
Possible 1A Stationary combustion if methane capture

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Energy Source</th>
<th>CO₂e Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desalination plants</td>
<td>1E Purchased electricity</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Biological treatment facilities</td>
<td>1E Purchased electricity</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Mechanical biological treatment (MBT) facilities</td>
<td>1E Purchased electricity</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Municipal waste incineration facilities</td>
<td>1G Stationary combustion of waste fuels</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Sanitary landfills</td>
<td>1F for renewable energy generated from landfill gas</td>
<td>&lt;100</td>
</tr>
</tbody>
</table>

Note: CO₂e emissions values are approximate and may vary depending on specific conditions and project details.
## ANNEX 2: DEFAULT EMISSIONS CALCULATION METHODOLOGIES

<table>
<thead>
<tr>
<th>Method #</th>
<th>Sector &amp; GHG</th>
<th>Calculation Input Data Requirements (i) (ii) etc.</th>
<th>Calculation Method</th>
</tr>
</thead>
</table>
| 1A       | Stationary fossil fuel combustion CO₂e | (i) Annual fuel use in energy units (e.g. TJ), volume or mass units  
 (ii) Fuel Emissions Factor (see table A2.1) | CO₂(t) = Fuel energy use * Emissions Factor |
| 1B       | Stationary fossil fuel combustion N₂O | (i) Annual fuel energy input (derive from data above)  
 (ii) Default emission factor (see table A2.1) 0.096 t N₂O / TJ energy input | N₂O(t) = Fuel energy input * emission factor |
| 1C       | Stationary biomass fuel combustion CH₄ and N₂O | (i) Fuel energy input (derive from data above)  
 (ii) Default emission factors:  
  - CH₄: Energy/manufacturing: 0.03 t CH₄ / TJ energy input  
  - Commercial/residential: 0.3 t CH₄ / TJ energy input  
  - N₂O: 0.004 t N₂O / TJ energy input | CH₄(t) = Fuel energy input * emission factor  
 N₂O(t) = Fuel energy input * emission factor  
 To convert to CO₂e multiply CH₄ by 21.  
 To convert to CO₂e multiply N₂O by 310 |
| 1D       | Cogeneration Combined Heat and Power (CHP) | Direct emissions from fuel combustion to follow methodology 1A above.  
 Allocation of emissions from the purchase or sale of energy from a CHP plant to be made according to the relevant GHG Protocol "Allocation of Emissions from a Combined Heat and Power (CHP) Plant" http://www.ghgprotocol.org/calculation-tools/all-tools | |
| 1E       | Purchased electricity CO₂e | (i) Energy Purchased for use in project activities  
 (ii) Country specific electricity grid factor (see table A2.3) or in special cases, such as electricity for pumped storage, the appropriate marginal plant | CO₂(t) = Energy use * Country Electricity Grid Emissions Factor |
| 1F       | Renewable energy projects CO₂e | Normally minor absolute emissions except for hydro with large reservoirs i.e. not run of river schemes or small hydro reservoir.  
 Production from renewable energy sources (wind, solar, run of river hydro, biomass, biogas and landfill gas) are assumed to displace (in part) marginal power/heat plants in the existing energy systems. Relative emissions estimates based on displacing existing power/heat plants will use fossil grid factors or emissions from displaced plants (see table A2.3). | CO₂(t) = Energy generated * Country Fossil Grid Emissions Factor |
| 1G       | Stationary combustion of waste type fuels | (i) Annual fuel use  
 (ii) Fuel Emissions Factor (see table A2.1) | CO₂(t) = Fuel use * Emissions Factor |
| 2        | Oil/gas production, processing, storage and transport CO₂, CH₄ | All combustion including flare emissions may be derived from 1a above.  
 Emissions of N₂O are not considered significant in petroleum refining and gas processing (IPIECA GHG Guidelines, 2003).  
 Fugitive emissions and venting tCO₂/yr = Volume or mass of ref. gas * Emissions Factor ref. gas |
<table>
<thead>
<tr>
<th>Method #</th>
<th>Sector &amp; GHG</th>
<th>Calculation Input Data Requirements (i) (ii) etc.</th>
<th>Calculation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Compressor emissions are calculated from fuel combustion as above or from purchased energy.</td>
<td>Fugitive ( \text{CH}_4 ) emissions factor * production</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Fugitive emissions</strong> -</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fugitive emissions are leaks from components such as pipe connections, valves, rotating shafts etc. The calculation of fugitive emissions is netly insensitive to the number of components and the benefit to be derived from identifying the precise number of components is negligible. A coarse estimate of component numbers, focusing on large potential sources such as compressors, is recommended</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) Facility production of transport system flow rates</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Emissions factor (see tables A2.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) API compendium lists a default approach as being to assume that storage tank working and breathing loss emissions are negligible for ( \text{CO}_2 ) and ( \text{CH}_4 ).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Storage tank fugitive emissions</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) API compendium lists a default approach as being to assume that tank working and breathing loss emissions are negligible for ( \text{CO}_2 ) and ( \text{CH}_4 ).</td>
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<tr>
<td></td>
<td></td>
<td><strong>Catalytic Regeneration</strong></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(i) Rated throughput of the unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Benchmark energy consumption for the unit from and verified feed or product density data as appropriate in kWh fuel (net)/t throughput</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Catalytic cracking unit factor (pet coke) = 0.358 kg CO(_2)/kWh*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Hydrogen generation</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) Hydrogen feed processed (conservatively based on ethane)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Hydrogen gen. emissions factor 2.19 tCO(_2)/t feed *</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>*EU ETS 2007</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>LNG Vaporisation</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>There are two common methods of vaporisation. The first is to use heated water baths in a submerged combustion vaporisation process. CO(_2) emissions arise from the combustion of fuel gas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) LNG design throughput</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Load factor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Apply 0.393 tCO(_2)/t LNG vaporised.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>(EU ETS benchmark for UK DTI 2006)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The second process is an open rack sea water system which involves no combustion but may use significant amounts of imported electricity to power</td>
<td></td>
</tr>
</tbody>
</table>

*SCV \( \text{tCO}_2 \) = tonnes LNG design capacity * load % * 0.393
<table>
<thead>
<tr>
<th>Method</th>
<th>Sector &amp; GHG</th>
<th>Calculation Input Data Requirements (i) (ii) etc.</th>
<th>Calculation Method</th>
</tr>
</thead>
</table>
| 3      | Coal mining  | (i) Annual mass of coal mined 
(ii) Default emission rates: 
- underground coal: 10 – 25 m3 CH4 / t coal 
- surface-mined coal: 0.3 – 2 m3 CH4 / t coal 
- underground, post-mining: 0.9 - 4 m3 CH4 / t coal 
- surface-mined, post-mining: 0 – 0.2 m3 CH4 / t coal | CH4 (t) = Coal mined (t) * 
(emission per tonne mined + emission per tonne post-mining) * 0.00067  
To convert to CO2e multiply methane by 21. |
| 4      | Electricity, Gas and Heat Transmission & Distribution | The project boundary for absolute emissions includes, for one average year, Scope 1 direct emissions, Scope 2 electricity consumption and fugitive losses from equipment and the network. 
(i) Distribution losses for the part or whole network (energy) 
(ii) Electricity consumption based on grid factor for country (table A2.3) 
(iii) Total quantity of SF6 in switchgear and circuit breakers 
(iv) Switchgear and circuit breakers: SF6 leakage rate Japan 0.001. Global pre 1996 = 0.05 and post 1996 = 0.02 
(fraction of SF6/yr) (IPCC Good Practice Guide 2000 table 3.12) 
(v) SF6 to CO2 conversion factor = 23900 
(vi) Fugitive emissions (see methodology 2) | Distn losses CO2 t/yr= 
energy loss (yr) * country factor  
SF6 (CO2 te/y) = SF6 project inventory(t) * SF6 leakage rate * SF6/CO2 emissions factor |
| 5      | Flue gas desulphurisation (limestone based) | (i) Annual usage of limestone (t) 
(ii) calcium carbonate content (% wt) 
(iii) magnesium carbonate content (% wt) | CO2 (t) = Annual usage (t) x 
[(% CaCO3 * 12/100) + (% MgCO3 * 12/84)] * 3.664 |
| 6      | Industrial processes | The main emission sources from industrial processes are those which chemically or physically transform materials. Industrial processes include: 
- Metal Industry processes, such as aluminium, iron, steel, lead, copper and zinc production. 
- Chemical industry processes, such as the production of nitric acid, ammonia, adipic acid production 
- Mineral industry processes, such as cement, lime, glass, soda ash production | If plant-level information is not available use 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 3 for default factors available on PJ Intranet. |
<table>
<thead>
<tr>
<th>Method #</th>
<th>Sector &amp; GHG</th>
<th>Calculation Input Data Requirements (i) (ii) etc.</th>
<th>Calculation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Other industry processes such as pulp and paper production The footprint calculation will include: (i) Emissions from 1A Stationary Combustion of Fossil Fuels (ii) Emissions from 1E purchased electricity (iii) Plant specific process emissions Plant-specific process emissions are those produced for industrial activities not related to energy.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Waste Water &amp; Sludge Treatment [\text{CO}_2, \text{CH}_4]</td>
<td>Significant \text{CH}_4 emissions from wastewater treatment (WWT) only arise from the anaerobic part of the process. Most EIB projects will involve aerobic WWT systems. However, the sewage sludge from aerobic systems may be treated by land-filling in anaerobic conditions giving rise to \text{CH}_4 emissions. A range of emissions factors is given in the column right dependent upon the waste water and sludge treatment method. These have been derived by EIB from the IPCC Good Practice Guide. Required inputs are population served and emissions factor Incineration of organic waste is treated as carbon neutral.</td>
<td>1. Aerobic wastewater treatment without primary sedimentation, with excess sludge thickening and dewatering, sludge disposal on land-fill [\text{CO}_2e (t/yr) = \text{Pop. Eq.} \times 0.1104] 2. Anaerobic waste water treatment (septic tank) [\text{CO}_2e (t/yr) = \text{Pop. Eq.} \times 0.2208] 3. Aerobic wastewater treatment without primary sedimentation, with excess sludge aerobic digestion, thickening and dewatering, sludge disposal on land-fill [\text{CO}_2e (t/yr) = \text{Pop. Eq.} \times 0.0552] 4. Aerobic wastewater treatment with primary sedimentation, with raw sludge aerobic digestion, thickening and dewatering, sludge disposal on land-fill [\text{CO}_2e (t/yr) = \text{Pop. Eq.} \times 0.0607] 5. Aerobic wastewater treatment with primary sedimentation, with raw sludge anaerobic digestion, thickening and dewatering, sludge disposal on land-fill [\text{CO}_2e (t/yr) = \text{Pop. Eq.} \times 0.0497]</td>
</tr>
<tr>
<td>8</td>
<td>Road transport [\text{CO}_2]</td>
<td>Proprietary model ERIAM is used. This takes project input data in the form of traffic data and costs data and calculates the emissions without the project, emissions with project for third party use of the project infrastructure in the form of existing and induced traffic indirect emissions. Induced traffic is determined by the analyst on a case by case basis according to circumstances of the project, usually by applying an appropriate elasticity to the percentage change in expected time savings in the opening year. The model has an assumed set of relationships</td>
<td>ERIAM.xls</td>
</tr>
<tr>
<td>Method #</td>
<td>Sector &amp; GHG</td>
<td>Calculation Input Data Requirements (i) (ii) etc.</td>
<td>Calculation Method</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>relating to speed and fuel use, speed and traffic flow and fuel use and GHG emissions. The sector expert can select the relative ratio of diesel and gasoline vehicles in use and the type of vehicles considered are light vehicle diesel and gasoline and heavy goods vehicle diesel. Emissions factors for fuel types can be entered by the user into the model. WRI GHG Protocol reference factors may be found in table A2.6 Emissions from the project construction phase are not to be included – UNDER REVIEW</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Rail transport</td>
<td>Proprietary model RAILMOD is used. This takes project input data on rail line lengths and uses and calculates the avoided emissions, absolute emissions and baseline emissions. Alternative modes that are considered are rail, high speed rail, car (truck for freight), bus and plane. Modal shift is accounted for. Emissions factors for fuel types can be entered by the user into the model. WRI GHG Protocol reference factors may be found in table A2.6 Emissions from the project construction phase are not to be included – UNDER REVIEW If the project is a rolling stock replacement, the project boundary is the fleet being replaced and the operation to which it is dedicated. Absolute emissions are those related to the operation carried out by these vehicles: the total yearly production in train-km for the replaced fleet is calculated. Based on this, on the average consumption (per car-km or train-km) of fossil fuel or of electric energy, and on the CO2 emission factor (grams of CO2 per litre of fossil fuel or per kWhr), the total fleet emissions per year are calculated (Scope 1 or 2 emissions). Modal shift effects in this case are usually limited.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Urban transport</td>
<td>Projects which exceed the 20 ktCO2 threshold in this category are normally transport infrastructures that result in emissions savings from the modal shift away from road transport (usually passenger vehicles). Absolute emissions from such projects are from the operation of the new infrastructures using the other transport methodology below. The project boundary includes the Scope 3 (indirect) GHG emissions from vehicles using the new/extended urban transport infrastructure during one average year of use. The power consumption rates for electrical train projects should be provided by the promoter if at all possible. Otherwise indicative energy use figures are provided in table The boundary only extends to the transport using the part of the infrastructure that is involved in the project, and not the entire urban transport network. If the project is the extension of an existing urban transport network, then the project boundary may be only this extension. If the transport usage is only quantifiable for the whole network, then a proportion must be calculated that equates to the extension only. This may be achieved using the ratio of existing and new offered capacity. The EIB will however, take account of all emissions from this project, regardless of the EIB contributing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MOB/PTR proprietary model which uses distance travelled and an emissions factor for the mode of transport. CO2= km * emissions factor</td>
<td></td>
</tr>
</tbody>
</table>
### Method 11: Other transport CO₂

**Maritime**
- If the project is financing a new fleet of vessels, the project boundary is the financed vessels and the operation to which they are dedicated. Absolute emissions are those related to the operation of these vessels: the total yearly production in km is estimated based on the route taken and number of trips per annum. Using this figure and the cargo capacity of the ship (e.g., measured in TEU/CEU), the emissions can be expressed by multiplying by the efficiency factor of the ship – expressed in g CO₂/tonne*km.

**Air**
- If the project is financing new aircraft, the project boundary is the financed aircraft and the operation to which they are dedicated. Absolute emissions are those related to the operation of these vehicles: the total yearly production in km is estimated based on the routes taken and number of trips per annum. Using this figure and the average occupancy of the plane in number of passengers, the emissions can be expressed by multiplying by the efficiency factor of the aircraft – expressed in g CO₂/pax*km.

### Method 12: Reservoirs CO₂, CH₄

- (i) Flooded total surface area
- (ii) CO₂ diffusive emissions factor (table A2.7)
- (iii) CH₄ diffusive emissions factor (table A2.7)
- (iv) CH₄ bubbles emissions factor (table A2.7)

The large uncertainties associated with IPCC emissions factors should be noted.

### Method 13: Waste treatment facilities

Absolute process emissions are calculated using default emission factors (IPCC 2006)

**Composting:**
- 4 kg CH₄ per ton waste
- 0.3 kg N₂O per ton waste

**Anaerobic digestion:**
- 1 kg CH₄ per ton waste

<table>
<thead>
<tr>
<th>Method #</th>
<th>Sector &amp; GHG</th>
<th>Calculation Input Data Requirements (i) (ii) etc.</th>
<th>Calculation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Other transport CO₂</td>
<td>Maritime</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Reservoirs CO₂, CH₄</td>
<td>(i) Flooded total surface area</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) CO₂ diffusive emissions factor (table A2.7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) CH₄ diffusive emissions factor (table A2.7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) CH₄ bubbles emissions factor (table A2.7)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Waste treatment facilities</td>
<td>Absolute process emissions are calculated using default emission factors (IPCC 2006)</td>
<td></td>
</tr>
<tr>
<td>Method #</td>
<td>Sector &amp; GHG</td>
<td>Calculation Input Data Requirements (i) (ii) etc.</td>
<td>Calculation Method</td>
</tr>
<tr>
<td>---------</td>
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<td>---------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>14</td>
<td>Municipal Solid Waste Landfill CH4</td>
<td>CH4 emissions are calculated using the IPCC 1996 Default Methodology Tier 1. This evaluates the total potential yield of methane from the waste deposited, expressed as an average annual emission. The following data are required: &lt;br&gt; (i) Annualised mass of MSW to be deposited, MSWT (t/y) &lt;br&gt; (ii) Methane Correction Factor (MCF) - reflecting the nature of the waste disposal practices and facility type. Recommended values are: Managed (i.e. controlled waste placement, fire control, and including some of the following: cover material, mechanical compacting or levelling): MCF = 1 Unmanaged - deep (&gt; 5m waste): MCF = 0.8 Unmanaged - shallow (&lt; 5m waste): MCF = 0.4 Uncategorised (default): MCF = 0.6 &lt;br&gt; (iii) Degradable Organic Carbon (DOC) - fraction of MSW that is degradable carbon. Default values are paper and textile - 40%; garden waste and other non-food putrescibles - 17% food waste - 15%; wood or straw - 30%. &lt;br&gt; (iv) Fraction of DOC dissimilated (DOCF) - i.e. the fraction that is ultimately degraded and released: default = 0.5 - 0.6 (IPCC Good Practice Guidelines)) &lt;br&gt; (v) Fraction by volume of CH4 in landfill gas &lt;br&gt; (vi) Mass of CH4 recovered per year for energy use or flaring, R (t/y) Fraction of CH4 released that is oxidised below surface within the site, OX. Default is OX = 0.1 for well-managed sites, otherwise 0.</td>
<td>Waste incineration: &lt;br&gt; 91.7 t CO₂ / TJ fossil municipal solid waste input &lt;br&gt; 14.3 t CO₂ / TJ industrial waste input &lt;br&gt; 0.03 t CH4 / TJ fossil municipal solid waste input &lt;br&gt; 0.004 t N2O / TJ fossil municipal solid waste input Relevant CO2 default emission factor for auxiliary fuel used</td>
</tr>
<tr>
<td>15</td>
<td>Refrigeration / Air conditioning / Insulation Industry HFCs</td>
<td>A variety of industrial processes involve refrigeration and air conditioning and thus indirectly employ HFCs. It is recommended that only where the manufacture and use of such equipment is a major aspect of a project should an assessment be undertaken. In such cases the user is referred to IPCC 1996 Reference Manual for recommended sector-specific calculation methods. See table A2.8 for GWP of HFCs.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Semiconductor and LCD manufacturing - construction and operation wafer plants</td>
<td>Electronics manufacturing processes utilise poly fluorinated compounds (PFCs) for plasma etching, intricate patterns, cleaning reactor chambers, and temperature control. The gases include CF4, C2F6, C3F8, c-C4F8, c-C4F8O, C4F6, C5F8, CHF3, CH2F2, NF3, and SF6.</td>
<td>Gas in to the process chamber, Gas out of the process chamber and % of the Gas out that is being retained by abatement systems.</td>
</tr>
<tr>
<td>Method #</td>
<td>Sector &amp; GHG</td>
<td>Calculation Input Data Requirements (i) (ii) etc.</td>
<td>Calculation Method</td>
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<td></td>
<td></td>
<td>In addition, more than 20 different liquid PFCs are marketed, often as mixtures of fully fluorinated compounds to the electronic sector. Evaporative losses contribute to the total FC emissions.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Building Refurbishment CO₂</td>
<td>(i) Electric Energy Purchased for use in the buildings</td>
<td>$CO_{2e}(t) = Electric\ Energy\ use \times Country\ Electricity\ Grid\ Emissions\ Factor + Heat\ Energy\ Use \times project\ specific\ heat\ emission\ factor$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Thermal Energy/ fuel purchased for use in the buildings</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Project specific heat emissions factor (District Heating, fossil fuel boilers (building or apartment level))</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Country specific electricity grid factor (see table A2.3)</td>
<td></td>
</tr>
</tbody>
</table>
Table A2.1: Default Emissions Factors

TF factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories these factors assume no unoxidized carbon. To account for unoxidized carbon, IPCC suggests multiplying by these default factors: solid = 0.98, liquid = 0.99, and gas = 0.995. Other factors are from WRI/WBCSD GHG protocol.

### GASEOUS FOSSIL FUELS

<table>
<thead>
<tr>
<th>Fuel Name</th>
<th>Amount of fuel</th>
<th>Units</th>
<th>kg CO₂</th>
<th>kg CH₄</th>
<th>kg N₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>1</td>
<td>metre³</td>
<td>1.9</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Natural gas</td>
<td>1 TJ</td>
<td>56100</td>
<td>1.0</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Refinery gas</td>
<td>1 metric tonne(t)</td>
<td>2851</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Refinery gas</td>
<td>1 TJ</td>
<td>57600</td>
<td>1.0</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Liquefied Petroleum Gases</td>
<td>1 litres (l)</td>
<td>1.6</td>
<td>0.0</td>
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### LIQUID FOSSIL FUELS

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<th>kg CH₄</th>
<th>kg N₂O</th>
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Table A2.1 (contd.) Default Emissions Factors

### SOLID FOSSIL FUELS

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<th>kg CO₂</th>
<th>kg CH₄</th>
<th>kg N₂O</th>
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### SOLID WASTE FUELS

*Factors are for non-biomass fractions. IPCC 2006 Stationary Combustion*

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<tr>
<th>Fuel Name</th>
<th>Amount of fuel</th>
<th>Units</th>
<th>kg CO₂</th>
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<td>Municipal Solid Waste (non biomass fraction)</td>
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<td>Waste oils</td>
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Table A2.2
Default Fugitive Emissions Factors Oil and Gas Production, Storage and Transport.

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<th>Production type</th>
<th>Emissions factor</th>
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| Onshore gas production           | 2.595E-02 tonnes CH₄/scf  
9.164E-01 tonnes CH₄/m            |
| Offshore gas production          | 1.038E-02 tonnes CH₄/scf  
3.665E-01 tonnes CH₄/m            |
| Onshore oil production           | 2.342E-04 tonnes CH₄/bbl  
1.473E-03 tonnes CH₄/m            |
| Offshore oil production          | 9.371E-05 tonnes CH₄/bbl  
5.894E-04 tonnes CH₄/m            |
| Gas processing plants            | 2.918E-02 tonnes CH₄/scf  
1.030E+00 tonnes CH₄/m            |
| Gas storage stations             | 6.754E+02 tonnes CH₄/station          |
| Gas transmission pipelines      | Total CO₂ = 58.13 tonnes /km-yr       |
| Gas distribution pipelines      | Total CO₂ = 42.3 tonnes /km-yr        |
| Crude transmission pipelines    | Negligible CH₄ fugitive equipment leak emissions |
| Refineries                      | Negligible CH₄ fugitive equipment leak emissions |
| LNG vaporisation using combustion | Total tCO₂ = Design throughput tonnes * 0.0393 |

Source: API Compendium 2004
Table A2.3 Purchased Electricity: Country Grid Emissions Factors (IEA CO₂ Statistics 2009)

Table A2.3 provides five different values for national country electricity grids with all figures expressed in grams CO₂ per kilowatt hour (g CO₂/kWh). The figures are net production data based on IEA national gross electricity and heat production statistics. The following fuel generation efficiency assumptions have been used to convert values to net production:

- Electricity generating efficiency (coal/oil) = 40%
- Electricity generating efficiency (gas) = 52%
- Heat generating efficiency = 90%
- Adjustment for auto-consumption = 7%

Table A2.3 includes the following information:

- Average country grid factor and low, medium and high voltage average grid factors: the net production factor including all generation methods. The average country grid factor is used solely as the reference value for the calculation of the grid average including transmission and distribution (T&D) losses and should not be used in project carbon footprint calculations. The application of the low, medium and high voltage grids should be used where default T&D loss values of 2, 4 and 7% have been applied. Where actual T&D losses are known these should be applied using the average grid as the reference value. Typical projects using low, medium and high voltage grids are as follows:
  - HV grid – high speed rail; heavy industry projects (e.g. mining, steel production)
  - MV grid – manufacturing plants; utilities
  - LV grid – commercial; residential projects

- Operating margin factor: this factor is used in combination with the build margin factor in the application of the project baseline for energy generation projects only. For details on how to apply the operating and build margin factors see Annex 3.

Where generation type e.g. coal, gas, oil etc. is known use factor from WRI purchased electricity worksheet available from www.wri.org

Figures expressed in g CO₂/kWh

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<th>Country</th>
<th>Country Grid Factor</th>
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<th>Medium Voltage Grid +4%</th>
<th>Low Voltage Grid +7%</th>
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<td>459</td>
<td>468</td>
<td>478</td>
<td>494</td>
<td>756</td>
</tr>
<tr>
<td>Memo: Annex II Parties</td>
<td>451</td>
<td>460</td>
<td>469</td>
<td>485</td>
<td>756</td>
</tr>
<tr>
<td>Memo: Annex II North America</td>
<td>506</td>
<td>517</td>
<td>527</td>
<td>544</td>
<td>790</td>
</tr>
<tr>
<td>Memo: Annex II Europe</td>
<td>315</td>
<td>322</td>
<td>328</td>
<td>339</td>
<td>667</td>
</tr>
</tbody>
</table>
### Table A2.4 Build Margin Electricity and Heat Generation Factors by Unit
(Assumptions made for build margin will be available in annex 3 which is being finalised by PJ Energy experts)

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Fuel</th>
<th>When to use for Build Margin</th>
<th>Emissions Factor (t CO2 / GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Cycle Gas Turbine (CCGT)</td>
<td>natural gas</td>
<td>Natural gas is available</td>
<td>354</td>
</tr>
<tr>
<td>Open Cycle Gas Turbine (GT)</td>
<td>natural gas</td>
<td></td>
<td>577</td>
</tr>
<tr>
<td>Industrial Steam Boiler</td>
<td>natural gas</td>
<td></td>
<td>217</td>
</tr>
<tr>
<td>Residential Heat Boiler</td>
<td>natural gas</td>
<td></td>
<td>224</td>
</tr>
<tr>
<td>Combined Cycle Gas Turbine (CCGT)</td>
<td>light fuel oil</td>
<td>Only fuel oil is available</td>
<td>485</td>
</tr>
<tr>
<td>Open Cycle Gas Turbine (GT)</td>
<td>light fuel oil</td>
<td></td>
<td>762</td>
</tr>
<tr>
<td>Diesel Engine Combustion</td>
<td>light fuel oil</td>
<td></td>
<td>606</td>
</tr>
<tr>
<td>Industrial Steam Boiler</td>
<td>light fuel oil</td>
<td></td>
<td>296</td>
</tr>
<tr>
<td>Residential Heat Boiler</td>
<td>light fuel oil</td>
<td></td>
<td>314</td>
</tr>
<tr>
<td>Diesel Engine Combustion</td>
<td>heavy fuel oil</td>
<td>Only fuel oil is available and if environmentally acceptable</td>
<td>633</td>
</tr>
<tr>
<td>Industrial Steam Boiler</td>
<td>heavy fuel oil</td>
<td></td>
<td>310</td>
</tr>
<tr>
<td>Super Critical Pulverised Coal</td>
<td>coal</td>
<td>Natural gas is not available or limited</td>
<td>804</td>
</tr>
<tr>
<td>Super Critical Pulverised Coal</td>
<td>lignite</td>
<td></td>
<td>866</td>
</tr>
<tr>
<td>Hydropower, Geothermal, Wind, Solar</td>
<td>renewable</td>
<td>Resources are available and economically viable</td>
<td>0</td>
</tr>
<tr>
<td>Nuclear</td>
<td>uranium</td>
<td>Not used for BM</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table A2.5 Integrated Iron and Steel Emissions Factors by Unit

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Emissions Factor</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke Oven - standard</td>
<td>0.15</td>
<td>t CO2 / t coke</td>
</tr>
<tr>
<td>Coke Oven with heat recovery and power generation</td>
<td>1.08</td>
<td>t CO2 / t coke</td>
</tr>
<tr>
<td>Sinter Strand</td>
<td>0.24</td>
<td>t CO2 / t sinter</td>
</tr>
<tr>
<td>Blast Furnace</td>
<td>0.31</td>
<td>t CO2 / t iron</td>
</tr>
<tr>
<td>BOS Furnace</td>
<td>0.06</td>
<td>t CO2 / t liquid steel</td>
</tr>
<tr>
<td>Continuous Casting Plant</td>
<td>0.00</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Hot Wide Strip Mills</td>
<td>0.10</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Annealing Line</td>
<td>0.06</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Billet Mills</td>
<td>0.26</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Reversing Mills</td>
<td>0.25</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Medium Section Mills</td>
<td>0.25</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Heavy Section Mills</td>
<td>0.29</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Bar Mills</td>
<td>0.16</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Section Mill</td>
<td>0.09</td>
<td>t CO2 / t steel</td>
</tr>
<tr>
<td>Secondary steelmaking</td>
<td>0.01</td>
<td>t CO2 / t liquid steel</td>
</tr>
</tbody>
</table>

---

7 Assumptions for Build Margin technologies can be found in Annex 3
8 Fugitive emissions from flue gas desulphurisation (FGD) are not included – FGD adds approximately 2-3% to the total CO2 emissions calculated on the basis of the fuel factors.
Source: Refer to EU ETS Phase II New Entrants’ Benchmark Review: Integrated Iron and Steel Benchmark Review Report

Table A2.6 Glass Production Carbonate Emissions Factors

<table>
<thead>
<tr>
<th>Carbonate</th>
<th>Emissions Factor [tCO₂/t carbonate]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO₃</td>
<td>0.44</td>
</tr>
<tr>
<td>MgCO₃</td>
<td>0.52</td>
</tr>
<tr>
<td>Na₂CO₃</td>
<td>0.42</td>
</tr>
<tr>
<td>BaCO₃</td>
<td>0.22</td>
</tr>
<tr>
<td>Li₂CO₃</td>
<td>0.60</td>
</tr>
<tr>
<td>K₂CO₃</td>
<td>0.32</td>
</tr>
<tr>
<td>SrCO₃</td>
<td>0.30</td>
</tr>
<tr>
<td>NaHCO₃</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Source: EU ETS Monitoring and Reporting Guidelines 2007

Tables A2.7 Transport Emissions Factors (UNDER REVIEW)


GUIDANCE: The following table is for indicative purposes only and if available the sector experts should use specific factors that relate to the project host country or specific technology. Where these factors are used the source should be recorded and their selection should comply with the principles of conservativeness and balance detailed in section 2 of the methodologies.

<table>
<thead>
<tr>
<th>ROAD</th>
<th>Emissions Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car - Gasoline *</td>
<td>0.21 kgCO₂/km</td>
</tr>
<tr>
<td>Passenger Car - Diesel *</td>
<td>0.20 kgCO₂/km</td>
</tr>
<tr>
<td>Light Goods Vehicle – diesel &lt;3 t gross</td>
<td>0.27 kgCO₂/km</td>
</tr>
<tr>
<td>Heavy Good Vehicle 3.5 – 33t gross weight</td>
<td>0.82 kgCO₂/km, 0.16 kgCO₂/t km</td>
</tr>
<tr>
<td>Heavy Good Vehicle &gt;33t gross weight</td>
<td>0.92 kgCO₂/km, 0.08 kgCO₂/t km</td>
</tr>
<tr>
<td>Average urban bus*</td>
<td>0.135 kg CO₂/passenger km, 0.015 kg CO₂/km</td>
</tr>
<tr>
<td>Average coach*</td>
<td>0.037 kg CO₂/passenger km, 0.002 kg CO₂/km</td>
</tr>
</tbody>
</table>

*2010 Guidelines to DEFRA/DECC’s GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors

<table>
<thead>
<tr>
<th>PASSENGER AIR</th>
<th>CO₂Emissions Factor</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air – domestic</td>
<td>0.158 kg/passenger km</td>
<td>65% load factor. B737-400 and Dash 8-Q400. 463 km</td>
</tr>
<tr>
<td>Air - short haul international</td>
<td>0.130 kg/passenger km</td>
<td>65% load factor. B737-400. 1108 km.</td>
</tr>
<tr>
<td>Air – long haul</td>
<td>0.106 kg/passenger km</td>
<td>80% load factor. B767-300ER and B747-400. 6482km</td>
</tr>
</tbody>
</table>

AIR FREIGHT
<table>
<thead>
<tr>
<th>Mode</th>
<th>CO₂ Emissions Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air – domestic</td>
<td>1.85 kg/t km</td>
</tr>
<tr>
<td></td>
<td>56.4% load factor. Aircraft cargo capacity 16 tonnes</td>
</tr>
<tr>
<td>Air - short haul</td>
<td>1.32 kg/t km</td>
</tr>
<tr>
<td></td>
<td>59.2% load factor. Aircraft cargo capacity 30 tonnes</td>
</tr>
<tr>
<td>Air – long haul</td>
<td>0.6 kg/t km</td>
</tr>
<tr>
<td></td>
<td>65.4% load factor. Aircraft cargo capacity 102 tonnes</td>
</tr>
</tbody>
</table>

**PASSGenger RAIL**

<table>
<thead>
<tr>
<th>Mode</th>
<th>CO₂ Emissions Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light rail</td>
<td>Sector expert defined using balanced and conservative factors from recorded sources. Or see table below for energy demand.</td>
</tr>
<tr>
<td>Tram</td>
<td>As above</td>
</tr>
<tr>
<td>Metro</td>
<td>As above</td>
</tr>
<tr>
<td>National rail</td>
<td>As above</td>
</tr>
<tr>
<td>High speed rail</td>
<td>As above</td>
</tr>
</tbody>
</table>
CO2 efficiency for cargo ships.

(Emissions factors to be used are from column “Emissions factor total efficiency”)

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Average cargo capacity (tonnes)</th>
<th>Average yearly capacity utilization</th>
<th>Average service speed</th>
<th>Emissions factor loaded efficiency g CO2/tonne km</th>
<th>Emissions factor total efficiency g CO2/tonne km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude tanker (oil)</td>
<td>200 000 dwt</td>
<td>295 237</td>
<td>48%</td>
<td>15.4</td>
<td>1.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Crude tanker (oil)</td>
<td>120 000 - 199 999 dwt</td>
<td>151 734</td>
<td>48%</td>
<td>15</td>
<td>2.2</td>
<td>4.4</td>
</tr>
<tr>
<td>Crude tanker (oil)</td>
<td>80 000 - 199 999 dwt</td>
<td>103 403</td>
<td>48%</td>
<td>14.7</td>
<td>3</td>
<td>5.9</td>
</tr>
<tr>
<td>Crude tanker (oil)</td>
<td>60 000 - 79 000 dwt</td>
<td>66 261</td>
<td>48%</td>
<td>14.6</td>
<td>4.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Crude tanker (oil)</td>
<td>10 000 - 59 999 dwt</td>
<td>38 631</td>
<td>48%</td>
<td>14.5</td>
<td>5.2</td>
<td>9.1</td>
</tr>
<tr>
<td>Crude tanker (oil)</td>
<td>0 - 9 999 dwt</td>
<td>3 668</td>
<td>48%</td>
<td>12.1</td>
<td>20.7</td>
<td>33.3</td>
</tr>
<tr>
<td>Products tanker</td>
<td>60 000 + dwt</td>
<td>101 000</td>
<td>55%</td>
<td>15.3</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Products tanker</td>
<td>20 000 - 59 999 dwt</td>
<td>40 000</td>
<td>55%</td>
<td>14.8</td>
<td>7.2</td>
<td>10.3</td>
</tr>
<tr>
<td>Products tanker</td>
<td>10 000 - 19 999 dwt</td>
<td>15 000</td>
<td>50%</td>
<td>14.1</td>
<td>11.3</td>
<td>18.7</td>
</tr>
<tr>
<td>Products tanker</td>
<td>5000 - 9999 dwt</td>
<td>7 000</td>
<td>45%</td>
<td>12.8</td>
<td>14.8</td>
<td>29.2</td>
</tr>
<tr>
<td>Products tanker</td>
<td>0 - 4 999 dwt</td>
<td>1 800</td>
<td>45%</td>
<td>11</td>
<td>26.5</td>
<td>45</td>
</tr>
<tr>
<td>Chemical tanker</td>
<td>20 000 + dwt</td>
<td>32 200</td>
<td>64%</td>
<td>14.7</td>
<td>5.7</td>
<td>8.4</td>
</tr>
<tr>
<td>Chemical tanker</td>
<td>10 000 - 19 999 dwt</td>
<td>15 000</td>
<td>64%</td>
<td>14.5</td>
<td>7.3</td>
<td>10.8</td>
</tr>
<tr>
<td>Chemical tanker</td>
<td>5 000 - 9 999 dwt</td>
<td>7 000</td>
<td>64%</td>
<td>14.5</td>
<td>10.7</td>
<td>15.1</td>
</tr>
<tr>
<td>Chemical tanker</td>
<td>0 - 4 999 dwt</td>
<td>1 800</td>
<td>64%</td>
<td>14.5</td>
<td>18.6</td>
<td>22.2</td>
</tr>
<tr>
<td>LPG tanker</td>
<td>50 000+ m3</td>
<td>46 656</td>
<td>48%</td>
<td>16.6</td>
<td>5.2</td>
<td>9</td>
</tr>
<tr>
<td>LPG tanker</td>
<td>0 - 49 000 m3</td>
<td>3 120</td>
<td>48%</td>
<td>14</td>
<td>27</td>
<td>43.5</td>
</tr>
<tr>
<td>LNG tanker</td>
<td>200 000+ m3</td>
<td>97 520</td>
<td>48%</td>
<td>19.6</td>
<td>8.4</td>
<td>14.5</td>
</tr>
<tr>
<td>LNG tanker</td>
<td>0 - 199 999 m3</td>
<td>621 000</td>
<td>48%</td>
<td>19.6</td>
<td>8.4</td>
<td>14.5</td>
</tr>
<tr>
<td>Bulk carrier</td>
<td>200 000 + dwt</td>
<td>227 000</td>
<td>50%</td>
<td>14.4</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Bulk carrier</td>
<td>100 000 - 199 999 dwt</td>
<td>163 000</td>
<td>50%</td>
<td>14.4</td>
<td>1.8</td>
<td>3</td>
</tr>
<tr>
<td>Bulk carrier</td>
<td>60 000 - 99 999 dwt</td>
<td>74 000</td>
<td>55%</td>
<td>14.4</td>
<td>2.7</td>
<td>4.1</td>
</tr>
<tr>
<td>Bulk carrier</td>
<td>35 000 - 59 999 dwt</td>
<td>45 000</td>
<td>55%</td>
<td>14.4</td>
<td>3.8</td>
<td>5.7</td>
</tr>
<tr>
<td>Bulk carrier</td>
<td>10 000 - 34 999 dwt</td>
<td>26 000</td>
<td>55%</td>
<td>14.3</td>
<td>5.3</td>
<td>7.9</td>
</tr>
<tr>
<td>Bulk carrier</td>
<td>0 - 9 999 dwt</td>
<td>2 400</td>
<td>60%</td>
<td>11</td>
<td>22.9</td>
<td>29.2</td>
</tr>
<tr>
<td>General cargo</td>
<td>10 000+ dwt 100+ TEU</td>
<td>18 000</td>
<td>60%</td>
<td>15.4</td>
<td>8.6</td>
<td>11</td>
</tr>
<tr>
<td>General cargo</td>
<td>5 000 - 9 999 dwt 100+ TEU</td>
<td>7 000</td>
<td>60%</td>
<td>13.4</td>
<td>13.8</td>
<td>17.5</td>
</tr>
<tr>
<td>General cargo</td>
<td>0 - 4 999 dwt 100+ TEU</td>
<td>4 000</td>
<td>60%</td>
<td>11.7</td>
<td>15.5</td>
<td>19.8</td>
</tr>
<tr>
<td>Refrigerated cargo</td>
<td>All</td>
<td>6 400</td>
<td>50%</td>
<td>20</td>
<td>12.9</td>
<td>12.9</td>
</tr>
<tr>
<td>Container</td>
<td>8 000+ TEU</td>
<td>68 600</td>
<td>70%</td>
<td>25.1</td>
<td>11.1</td>
<td>12.5</td>
</tr>
<tr>
<td>Container</td>
<td>5 000 - 7 999 TEU</td>
<td>40 355</td>
<td>70%</td>
<td>25.3</td>
<td>15.2</td>
<td>16.6</td>
</tr>
<tr>
<td>Container</td>
<td>3 000 - 4 999 TEU</td>
<td>28 784</td>
<td>70%</td>
<td>25.3</td>
<td>15.2</td>
<td>16.6</td>
</tr>
<tr>
<td>Container</td>
<td>2 000 - 2 999 TEU</td>
<td>16 800</td>
<td>70%</td>
<td>20.9</td>
<td>18.3</td>
<td>20</td>
</tr>
<tr>
<td>Container</td>
<td>1 000 - 1 999 TEU</td>
<td>7 000</td>
<td>70%</td>
<td>19</td>
<td>29.4</td>
<td>32.1</td>
</tr>
<tr>
<td>Container</td>
<td>0 - 999 TEU</td>
<td>3 500</td>
<td>70%</td>
<td>17</td>
<td>33.3</td>
<td>36.3</td>
</tr>
<tr>
<td>Vehicle</td>
<td>4 000+ CEU</td>
<td>7 908</td>
<td>70%</td>
<td>19.4</td>
<td>25.2</td>
<td>32</td>
</tr>
<tr>
<td>Vehicle</td>
<td>0 - 3 999 CEU</td>
<td>2 808</td>
<td>70%</td>
<td>17.7</td>
<td>47.2</td>
<td>57.6</td>
</tr>
<tr>
<td>Ro-ro</td>
<td>2 000+ LM</td>
<td>5 154</td>
<td>70%</td>
<td>19.4</td>
<td>45.3</td>
<td>49.5</td>
</tr>
<tr>
<td>Ro-ro</td>
<td>0 - 1 999 LM</td>
<td>1 432</td>
<td>70%</td>
<td>13.2</td>
<td>55.2</td>
<td>60.3</td>
</tr>
</tbody>
</table>

From Second International Maritime Organization Second GHG Study 2009 Table 9.1

Note: Note: “Loaded efficiency” is the theoretical maximum efficiency when the ship is fully loaded at service speed/85% load. Since engine load at the fully loaded condition is higher than the average including ballast and other voyages, the difference between the columns “loaded efficiency” and “total efficiency” cannot be explained by differences in utilization only.

LM = lane meters, TEU = twenty foot equivalent unit containers, CEU = car equivalent units
## FUEL FACTORS

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>kg CO₂ / litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline/petrol</td>
<td>2.33</td>
</tr>
<tr>
<td>on-road diesel fuel</td>
<td>2.68</td>
</tr>
<tr>
<td>residual fuel oil (3s 5 and 6)</td>
<td>3.12</td>
</tr>
<tr>
<td>LPG</td>
<td>1.53</td>
</tr>
<tr>
<td>CNG</td>
<td>0.054 (kg/ scf)</td>
</tr>
<tr>
<td>LNG</td>
<td>1.18</td>
</tr>
<tr>
<td>Ethanol</td>
<td>1.47</td>
</tr>
<tr>
<td>100% biodiesel</td>
<td>2.50</td>
</tr>
<tr>
<td>Jet fuel</td>
<td>2.53</td>
</tr>
<tr>
<td>Aviation gasoline</td>
<td>2.20</td>
</tr>
<tr>
<td>E85 ethanol/gasoline</td>
<td></td>
</tr>
<tr>
<td>- bio fuel component</td>
<td>1.25</td>
</tr>
<tr>
<td>- fossil fuel component</td>
<td>0.35</td>
</tr>
<tr>
<td>B20 biodiesel/diesel</td>
<td></td>
</tr>
<tr>
<td>- bio fuel component</td>
<td>0.50</td>
</tr>
<tr>
<td>- fossil fuel component</td>
<td>2.15</td>
</tr>
<tr>
<td>Marine diesel/gas oil</td>
<td>3.206 tCO₂/t</td>
</tr>
<tr>
<td>Light Fuel Oil</td>
<td>3.151 tCO₂/t</td>
</tr>
<tr>
<td>Heavy Fuel Oil</td>
<td>3.114 tCO₂/t</td>
</tr>
<tr>
<td>LPG</td>
<td>2.967 tCO₂/t</td>
</tr>
<tr>
<td>Nat Gas</td>
<td>2.931 tCO₂/t</td>
</tr>
</tbody>
</table>

Source: IPCC and IMO

## Indicative energy demand factors for electric rail transport

<table>
<thead>
<tr>
<th>Mode</th>
<th>kWhr/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic subway</td>
<td>2.61</td>
</tr>
<tr>
<td>London underground</td>
<td>2.84</td>
</tr>
<tr>
<td>Siemens combo 28t, 27 mtr LRV</td>
<td>1.53</td>
</tr>
<tr>
<td>Siemens SD160 42t, 25 mtr</td>
<td>3.23</td>
</tr>
<tr>
<td>French TGV</td>
<td>13.2</td>
</tr>
<tr>
<td>French TGV Duplex</td>
<td>18</td>
</tr>
<tr>
<td>Danish railway</td>
<td>6.7</td>
</tr>
<tr>
<td>Virgin Pendolina UK trains (9 cars)</td>
<td>14.4</td>
</tr>
<tr>
<td>Swedish 2 car trains</td>
<td>5.91</td>
</tr>
</tbody>
</table>

Source
- Environment Canada Factsheet 93-1
- London Underground environmental report 2005 & UK Dft passenger figures
- Siemens study – Basel LRV system
- Siemens Study Calgary Transit
- 1997 EC study estimating emissions from railway traffic.
- 1997 EC study
- Energy consumption & related emissions

Other sources of acceptable transport emissions factors that may be used can be found at:
- http://www.ex-tremis.eu/
- http://www.ecotransit.org/information.en.phtml
### Table A2.8 Reservoir GHG Emissions Factors

*Source: IPCC Good Practice Guidance for LULUCF*

**GUIDANCE:** The key default values needed to implement the EIB methodologies are emission factors for CO2, CH4 and N2O via the diffusion pathways, and an emission factor for CH4 via the bubbles pathways. The table below provides default emission factors for various climate zones that can be used. These default emission factors integrate some spatial and temporal variations in the emissions from reservoirs, as well as fluxes at the water-air interface of reservoirs. All default data have been obtained from measurements in hydroelectric or flood control reservoirs. The emissions factors for the ice-free period should be used for the entire year.

<table>
<thead>
<tr>
<th>Climate</th>
<th>CH4</th>
<th>CO2</th>
<th>N2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffusive emissions (ice-free period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ei (GHG)diff (kg ha⁻¹ d⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boreal, wet</td>
<td>0.11 ± 88%</td>
<td>15.5 ±56%</td>
<td>0.008 ±300%</td>
</tr>
<tr>
<td>Cold temperate, wet</td>
<td>0.2 ±55%</td>
<td>9.3 ±55%</td>
<td>nm</td>
</tr>
<tr>
<td>Warm temperate, dry</td>
<td>0.063 ± 0.032</td>
<td>-3.1 ±3.6</td>
<td>nm</td>
</tr>
<tr>
<td>Warm Temperate, wet</td>
<td>0.063 ± 0.032</td>
<td>13.2 ±6.9</td>
<td>nm</td>
</tr>
<tr>
<td>Tropical, wet</td>
<td>0.64 ±330%</td>
<td>60.4 ±145%</td>
<td>0.05 ±100%</td>
</tr>
<tr>
<td>Tropical, moist-long dry season</td>
<td>0.31 ±190%</td>
<td>11.65 ±260%</td>
<td>nm</td>
</tr>
<tr>
<td>Tropical, moist-short dry season</td>
<td>0.44 ±465%</td>
<td>35.1 ±290%</td>
<td>nm</td>
</tr>
<tr>
<td>Tropical, dry</td>
<td>0.3 ±115%</td>
<td>58.7 ±270%</td>
<td>nm</td>
</tr>
<tr>
<td>Bubbles emissions (ice-free period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ei (GHG)bubble (kg ha⁻¹ d⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boreal, wet</td>
<td>0.29 ±160%</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Tropical, wet</td>
<td>2.83 ±45%</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Tropical, moist-long dry season</td>
<td>1.9 ±155%</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Tropical, moist-short dry season</td>
<td>0.13 ±135%</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Tropical, dry</td>
<td>0.3 ±324%</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

**Emissions associated with the ice cover period**

<table>
<thead>
<tr>
<th>Boreal, wet</th>
<th>Ei (GHG)diff + Ei (GHG)bubble (kg ha⁻¹ d⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05 ±60%</td>
<td>0.45 ±55%</td>
</tr>
</tbody>
</table>
### Table A2.8 IPCC Global Warming Potential Factors

*Source: Intergovernmental Panel on Climate Change. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Reporting Instructions, 1997*

<table>
<thead>
<tr>
<th>Gas</th>
<th>Chemical formula</th>
<th>Global warming potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>CO₂</td>
<td>1</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>21</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>N₂O</td>
<td>310</td>
</tr>
<tr>
<td><strong>Hydrofluorocarbons (HFCs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFC-23</td>
<td>CHF₃</td>
<td>11 700</td>
</tr>
<tr>
<td>HFC-32</td>
<td>CH₂F₃</td>
<td>650</td>
</tr>
<tr>
<td>HFC-41</td>
<td>CH₃F</td>
<td>150</td>
</tr>
<tr>
<td>HFC-43-10mee</td>
<td>C₃H₂F₁₀</td>
<td>1 300</td>
</tr>
<tr>
<td>HFC-125</td>
<td>C₂HF₅</td>
<td>2 800</td>
</tr>
<tr>
<td>HFC-134</td>
<td>C₂H₂F₄ (CHF₂CHF₂)</td>
<td>1 000</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>C₂H₂F₄ (CH₂F₆CHF₂)</td>
<td>1 300</td>
</tr>
<tr>
<td>HFC-143</td>
<td>C₂H₃F₃ (CHF₂CH₂F)</td>
<td>300</td>
</tr>
<tr>
<td>HFC-143a</td>
<td>C₂H₃F₃ (CF₃CH₃)</td>
<td>3 800</td>
</tr>
<tr>
<td>HFC-152a</td>
<td>C₂H₄F₂ (CH₃CHF₂)</td>
<td>140</td>
</tr>
<tr>
<td>HFC-227ea</td>
<td>C₃HF₇</td>
<td>2 900</td>
</tr>
<tr>
<td>HFC-236fa</td>
<td>C₃H₅F₆</td>
<td>6 300</td>
</tr>
<tr>
<td>HFC-245ca</td>
<td>C₃H₅F₅</td>
<td>560</td>
</tr>
<tr>
<td><strong>Hydrofluoroethers (HFEs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFE-7100</td>
<td>C₄F₉OCH₃</td>
<td>500</td>
</tr>
<tr>
<td>HFE-7200</td>
<td>C₄F₉OC₂H₅</td>
<td>100</td>
</tr>
<tr>
<td><strong>Perfluorocarbons (PFCs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfluoromethane (tetrafluoromethane)</td>
<td>CF₄</td>
<td>6 500</td>
</tr>
<tr>
<td>Perfluoroethane (hexafluoroethane)</td>
<td>C₂F₆</td>
<td>9 200</td>
</tr>
<tr>
<td>Perfluoropropane</td>
<td>C₃F₈</td>
<td>7 000</td>
</tr>
<tr>
<td>Perfluorobutane</td>
<td>C₄F₁₀</td>
<td>7 000</td>
</tr>
<tr>
<td>Perfluorocyclobutane</td>
<td>C₅F₁₂</td>
<td>8 700</td>
</tr>
<tr>
<td>Perfluoropentane</td>
<td>C₆F₁₄</td>
<td>7 500</td>
</tr>
<tr>
<td>Perfluorohexane</td>
<td>SF₆</td>
<td>7 400</td>
</tr>
<tr>
<td>Sulfur hexafluoride</td>
<td></td>
<td>23 900</td>
</tr>
</tbody>
</table>
ANNEX 3: APPLICATION OF ELECTRICITY GRID EMISSION FACTORS FOR PROJECT BASELINES

1. ELECTRICITY GENERATION PROJECTS

With respect to energy generation projects, it is recommended that for grid-connected electricity generating projects a weighted average of operating margin and build margin should be used to define the baseline emissions of the project. EIB has adopted and applied a methodology approved by the CDM Executive Board to calculate the operating and build margin emission factors: Tool to Calculate Emission Factor for an Electricity System

1.1 Operating Margin

The operating margin (OM) is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed project activity. In principle, it would comprise the marginal power plants affected by the operation of the project and could include any type of generation. For special cases (peak power, pumped storage or direct replacement) this definition should be used and specific marginal plants can be assumed for the OM. However, as a reference for most projects, it is assumed that the OM emissions are made up of the average emissions of thermal power generation in the electricity system, including natural gas, oil, coal and lignite generation and excluding existing renewable, nuclear and “must run” fossil such as district heating plants which would not normally be affected by the project.

Table A2.3 in the methodologies (p.38) presents the grid emission factors and OM on a per country basis. The grid factor calculation is based on OECD published data and includes CO₂ emissions from the entire generation park, i.e. fossil fuel, renewable, nuclear, waste-to-energy.

1.2 Build Margin

The build margin (BM) is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the proposed project activity. EIB takes a five-year forward looking perspective when determining the build margin technologies.

In principle, gas, fuel oil, coal, lignite, renewable energy (mainly intermittent) and nuclear plants may be built in Europe and could be part of the build margin. However, for simplicity and taking a conservative position on CO₂ emissions savings made by renewable energy, on mainland Europe where natural gas is available, the build margin for base load power plants connected to the grid will be assumed to be 100% based on the emissions from combined cycle gas turbine (CCGT) technology. On isolated island grids where gas is not available or where large scale power plants are not feasible, the BM will be based on the most appropriate fuel oil alternative (CCGT or diesel engine). For peak load generation, the most appropriate alternative may include a combination of base load and peak load power plants (open cycle gas turbines or diesel engines). The BM for heat boilers will be based on natural gas where gas distribution networks are available, or otherwise on fuel oil.

The same principles apply for the baseline in countries outside Europe, except for countries where large scale power plants are required and gas is not available. In these countries, the only viable thermal alternative will include coal. In addition, where significant sources of hydro and geothermal power are available (firm as opposed to intermittent), renewable energy may also make a significant contribution to the baseline.

Table A3.1 & A3.2 illustrate the BM emission factors applied for each generation type and the assumptions EIB has made for these.
Table A3.1 Electricity and Heat Generation Build Margins

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Fuel</th>
<th>When to use for Build Margin</th>
<th>Emissions Factor (t CO2 / GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELEC.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydropower, Geothermal, Wind, Solar</td>
<td>renewable</td>
<td>Resources are available and economically viable</td>
<td>0</td>
</tr>
<tr>
<td>Nuclear</td>
<td>uranium</td>
<td>Not used for BM</td>
<td>0</td>
</tr>
<tr>
<td>Combined Cycle Gas Turbine (CCGT)</td>
<td>natural gas</td>
<td></td>
<td>354</td>
</tr>
<tr>
<td>Combined Cycle Gas Turbine (CCGT)</td>
<td>light fuel oil</td>
<td>Natural gas is not available</td>
<td>485</td>
</tr>
<tr>
<td>Open Cycle Gas Turbine (GT)</td>
<td>natural gas</td>
<td></td>
<td>577</td>
</tr>
<tr>
<td>Open Cycle Gas Turbine (GT)</td>
<td>light fuel oil</td>
<td>Natural gas is not available</td>
<td>762</td>
</tr>
<tr>
<td>Diesel Engine Combustion</td>
<td>light fuel oil</td>
<td>Natural gas is not available</td>
<td>606</td>
</tr>
<tr>
<td>Diesel Engine Combustion</td>
<td>heavy fuel oil</td>
<td>Natural gas is not available</td>
<td>633</td>
</tr>
<tr>
<td>Super Critical Pulverised Coal (^1)</td>
<td>coal</td>
<td>Natural gas is not available</td>
<td>804</td>
</tr>
<tr>
<td>Super Critical Pulverised Coal (^1)</td>
<td>lignite</td>
<td>Resources are available and economically viable</td>
<td>866</td>
</tr>
<tr>
<td><strong>HEAT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Steam Boiler</td>
<td>natural gas</td>
<td></td>
<td>217</td>
</tr>
<tr>
<td>Industrial Steam Boiler</td>
<td>light fuel oil</td>
<td>Natural gas is not available</td>
<td>296</td>
</tr>
<tr>
<td>Industrial Steam Boiler</td>
<td>heavy fuel oil</td>
<td>Natural gas is not available</td>
<td>310</td>
</tr>
<tr>
<td>Residential Heat Boiler</td>
<td>natural gas</td>
<td></td>
<td>224</td>
</tr>
<tr>
<td>Residential Heat Boiler</td>
<td>light fuel oil</td>
<td>Natural gas is not available</td>
<td>314</td>
</tr>
</tbody>
</table>

Table A3.2 Assumptions for Electricity and Heat Build Margins

<table>
<thead>
<tr>
<th>Assumptions for electricity and heat Build Margins</th>
<th>Fuel</th>
<th>Generation efficiency</th>
<th>CO2 factor</th>
<th>t CO2/GWh</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELECTRICITY:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined cycle gas turbine</td>
<td>gas</td>
<td>0.57</td>
<td>56.1</td>
<td>354</td>
</tr>
<tr>
<td>Combined cycle gas turbine</td>
<td>LFO</td>
<td>0.55</td>
<td>74.1</td>
<td>485</td>
</tr>
<tr>
<td>Open cycle gas turbine</td>
<td>gas</td>
<td>0.35</td>
<td>56.1</td>
<td>577</td>
</tr>
<tr>
<td>Diesel engine</td>
<td>LFO</td>
<td>0.44</td>
<td>74.1</td>
<td>606</td>
</tr>
<tr>
<td>Diesel engine</td>
<td>HFO</td>
<td>0.44</td>
<td>77.4</td>
<td>633</td>
</tr>
<tr>
<td>Supercritical pulverised, ST</td>
<td>coal</td>
<td>0.44</td>
<td>98.3</td>
<td>804</td>
</tr>
<tr>
<td>Supercritical pulverised, ST</td>
<td>lignite</td>
<td>0.42</td>
<td>101.0</td>
<td>866</td>
</tr>
<tr>
<td><strong>HEAT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial steam boiler</td>
<td>gas</td>
<td>0.93</td>
<td>56.1</td>
<td>217</td>
</tr>
<tr>
<td>Industrial steam boiler</td>
<td>LFO</td>
<td>0.90</td>
<td>74.1</td>
<td>296</td>
</tr>
<tr>
<td>Industrial steam boiler</td>
<td>HFO</td>
<td>0.90</td>
<td>77.4</td>
<td>310</td>
</tr>
<tr>
<td>Residential heat boiler</td>
<td>gas</td>
<td>0.90</td>
<td>56.1</td>
<td>224</td>
</tr>
<tr>
<td>Residential heat boiler</td>
<td>LFO</td>
<td>0.85</td>
<td>74.1</td>
<td>314</td>
</tr>
</tbody>
</table>

1.3 Application of OM and BM factors

In the case of an electricity system in equilibrium, the following weightings should be used for OM/BM where energy demand growth is low to moderate, <5%:
• **50% OM/ 50% BM** should be applied as the baseline for firm capacity generation projects – e.g. thermal power plants and dispatchable renewables such as hydropower with storage or CSP with storage. In a country with relatively low to moderate demand growth, the commissioning of a base load plant can always be associated both with the replacement of existing capacity and the deferment of new capacity. The 50/50 default is acceptable for many projects and in line with the recommendations of the methodologies approved by the UNFCCC.

• **75% OM/ 25% BM** should be applied as the baseline for intermittent generation projects – e.g. renewable energy such as onshore and offshore wind and solar PV. Projects with intermittent capacity have a legitimate reason for deviating from the 50/50 default weights since non-firm generation and will displace a lower share of BM.

In the case of an electric system experiencing high demand growth, > 5% per annum, or suffering significant power deficits, the following OM/BM weightings should be used:

• **25% OM/ 75% BM** should be applied as the baseline in the case of firm capacity in an electricity system in a sizeable deficit condition. The BM weight under these conditions will be higher, between 50% and 100%. To simplify, a weighting of 25% OM / 75% BM is adopted in such cases.

• **50% OM/ 50% BM** should be applied for intermittent generation under similar conditions. The BM weight will shift up for the same reason outlined in the firm capacity scenario and so a 50/50 OM/BM split should be used for simplicity.

**2. PURCHASED ELECTRICITY**

Projects that purchase electricity from the grid must take into account the losses from the transmission and distribution (T&D) of the electricity. The size of the losses will depend on the project’s capacity, i.e. whether it is connected to the high, medium or low voltage grid. The grid emission factors, including T&D losses, are located in table A2.3 in the methodologies. For simplicity T&D losses are assumed to be as follows:

• High voltage grid: 2% T&D losses. Projects with >10MW consumption generally will be connected to the high voltage grid, e.g. high-speed rail, large heavy industry projects

• Medium voltage grid: 4% T&D losses. This includes most industry projects

• Low voltage grid: 7% T&D losses. This includes all residential and commercial projects.
GLOSSARY

**Absolute (Ab) GHG emissions.** Annual emissions estimated for an average year of operation.

**Baseline (Be) GHG emissions.** The project baseline emissions arise from the expected alternative scenario that reasonably represents the anthropogenic emissions by sources of GHGs that would have occurred in the absence of the project.

**Direct GHG emissions.** Fugitive, combustion or chemical processes related emissions from sources that are owned or controlled by the reporting company inside the project boundary. See scope 1 emissions.

**Emissions.** The release of GHG into the atmosphere.

**Emission factor.** A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and gross GHG emissions.

**Fugitive emissions.** Emissions that are not physically controlled but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing transmission storage and use of fuels and other chemicals, often through joints, seals, packing, gaskets, etc.

**Greenhouse gases (GHG).** GHGs are the seven gases listed in the Kyoto Protocol: carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF₆); and nitrogen trifluoride (NF₃).

**Global Warming Potential (GWP).** A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO₂.

**Indirect GHG emissions.** Emissions that are a consequence of the operations of the project, but occur at sources owned or controlled by another company e.g. purchased electricity. See scope 2 and scope 3 emissions.

**Process emissions.** Emissions generated from manufacturing processes, such as the CO₂ that arises from the breakdown of calcium carbonate (CaCO₃) during cement manufacture

**Project boundaries.** The boundaries that determine the direct and indirect emissions associated with operations owned or controlled by the project. This assessment allows a project developer (investor) to establish which operations and sources cause direct and indirect emissions, and to decide which indirect emissions to include that are a consequence of the project operations

**Relative emissions.** The difference (delta) between the absolute project emissions and the baseline scenario emissions.